TEST EQUIPMENT

INSTRUCTION MANUAL

COMPLEX IMPEDANCE-ADMITTANCE METER

MODEL 100B

DRANETZ
ENGINEERING
LABORATORIES
INCORPORATED

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SECTION I

GENERAL INFORMATION

1-1 INTRODUCTION

1-2 The Model 100B Complex Impedance-Admittance Meter (CIAM-100B) is a portable, completely transistorized instrument which measures vector impedance, vector admittance, capacitance and inductance rapidly, directly and accurately. (See figure 1-1.)

1-3 The Complex Impedance-Admittance Meter provides direct and accurate meter readings for either equivalent series resistance and reactance, or equivalent parallel conductance and susceptance. It covers a broad frequency range from 100 cps to 200 kc, and eliminates point-by-point balancing required in bridge systems. The unit provides approximately 1 volt d-c outputs for X-Y recorders, oscilloscopes or other recording instruments.

1-4 The Complex Impedance-Admittance Meter utilizes plug-in circuits throughout. The standard unit is supplied with Impedometer-Admittometer Plug-in Model 100-PA-1001 to provide a wide range of impedance and admittance measurements. Other plug-in modules can be provided for special application. (See Appendix C for operation of Model 100-PA-1001A Plug-in).

1-5 CAPABILITIES

1-6 With an unknown impedance connected to the panel terminals, at any frequency in the range this instrument provides a direct reading of impedance or admittance. In the impedance measuring mode, two precision mirror scale meters provide direct readings of R and ±X (without sign ambiguity) where $Z = R \pm jX$. In the admittance measuring mode, the same meters read directly G and ±B where $1/Z = G \pm jB$.

1-7 Since the susceptance of a capacitor is directly proportional to capacitance, at predetermined frequencies, the capacitance may be read directly on the susceptance meter. At a frequency of 159 kc, for example, the susceptance meter reads directly in picofarads. Similarly, the reactance meter can be used to read inductance directly. At 159 kc, this meter reads directly in microhenries.

1-8 In addition to providing direct meter readings, this instrument may also be used with X-Y recorders or oscilloscopes, as well as with strip chart recorders in order to obtain continuous locus curves in the complex impedance plane, in the complex admittance plane, or as a function of frequency. In the accompanying photograph (figure 1-2) is shown an

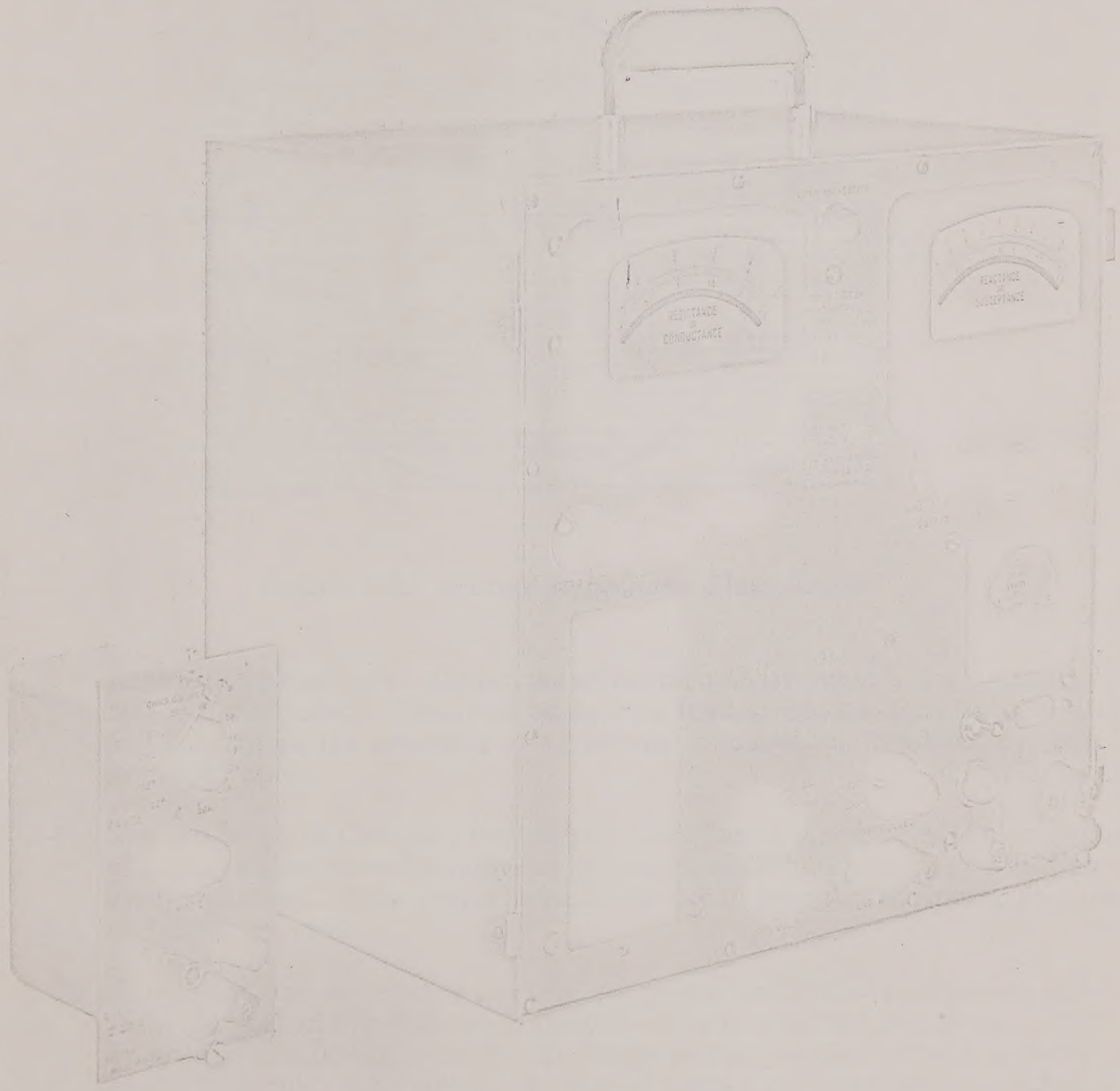


Figure 1-1. Complex Impedance-Admittance Meter Model 100B
and
Impedometer-Admittometer Plug-in Model 100-PA-1001

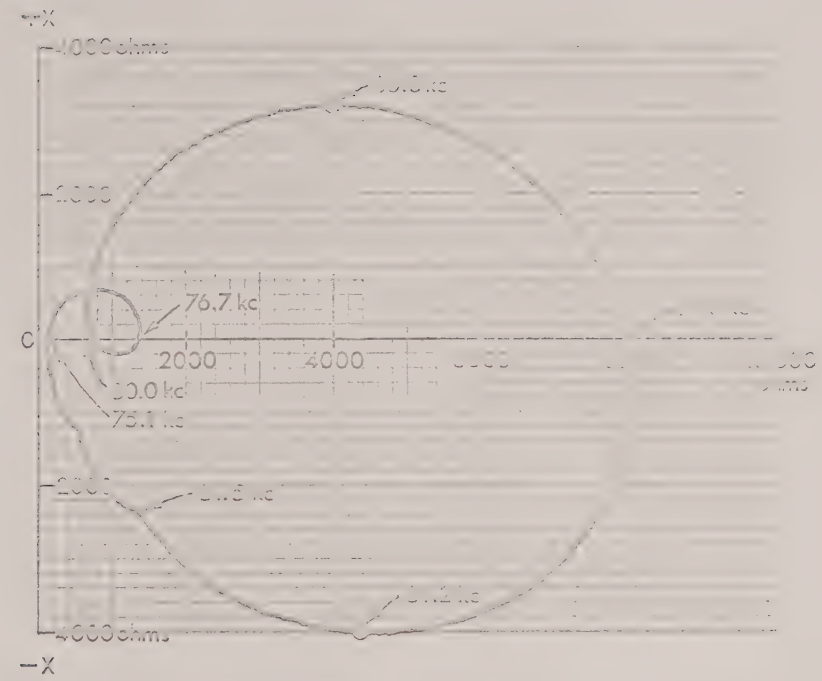


Figure 1-2. Plotted Impedance Plane Locus

impedance plane locus plotted using Electro-Instruments, Inc. model 500 X-Y Recorder. This was taken on a lead zirconate-lead titanate disc, and illustrates the presence of a secondary resonance in addition to the principal mode.

1-9 The model 100B Complex Impedance-Admittance Meter is based on the use of an impedometer-admittometer circuit in conjunction with sine and cosine resolvers. This system avoids the point-by-point balancing required by bridge systems.

1-10 For measuring impedance the internal power oscillator produces a constant current in the unknown impedance at any selected frequency. The amplitude of current is set by the range switch position, which is calibrated in ohms. The voltage developed across the unknown impedance is amplified and fed to two resolvers. The d-c output of the first resolver is proportional to the product of voltage across the unknown and the cosine of the angle between current and the voltage developed across the unknown. Hence the output is proportional to the in-phase component of unknown impedance. Similarly, the output of the second resolver is proportional to the quadrature, or reactive, component of impedance. The outputs are amplified and connected to precision panel meters, as well as to external recorder terminals through low output impedance circuits.

1-11 For measuring admittance, a constant voltage is placed across the unknown at any preselected frequency. The current through the unknown is measured by means of voltage developed across a small range-selected resistor placed in series with the unknown. This voltage is proportional to unknown admittance, and its phase angle relative to the input voltage is equal to the phase angle of the unknown admittance. This voltage is amplified and fed to the two resolvers as in the impedance case. Now, however, the resolver outputs are proportional to equivalent parallel conductance and susceptance of the unknown.

1-12 In both impedance and admittance measurements, the full scale meter readings are initially precalibrated by the use of a precision transfer standard placed in the impedometer or admittometer location. In this manner, errors are avoided which might otherwise come about through typical voltage or current measurements.

1-13 TECHNICAL CHARACTERISTICS

The operating characteristics and specifications of the Complex Impedance-Admittance Meter are listed in table 1-1. See Bulletin 100 in rear of manual.

1-14 ACCESSORIES AVAILABLE

The Complex Impedance-Admittance Meter is provided with a power cable, a 3- to 2-prong power cord adapter and a test adapter. The test adapter can be inserted between any internal plug-in module and the main chassis for exposing the plug-in terminal connections to facilitate troubleshooting. The test adapter is mounted on the rear of the main chassis inside the carrying case.

1-15 INSTALLATION

The instrument is shipped ready for operation. Special instructions for applying power are listed below:

a. Connect the instrument into a 115-volt 60 cps source.

b. The instrument must be grounded at the ground terminal (located on plug-in section) or through the power cable, but not at both terminals.

CAUTION

DO NOT APPLY D-C VOLTAGE
ACROSS ANY EXPOSED TERMINALS
OF THIS INSTRUMENT.

Table 1-1. Specifications for Model 100B

Impedance Ranges (Full Scale R&X)

10, 25, 50, 100, 250, 500, 1K, 2.5K, 5K, 10K, 25K, 50K ohms (Can also measure 10 microhenries full scale to 50 henries full scale, depending on frequency. Higher ranges of impedance possible using admittance mode)

Admittance Ranges (Full Scale G&B)

10, 25, 50, 100, 250, 500, 1K, 2.5K, 10K, 25K, 50K micromhos (can measure 10 mmfd full scale to 50 mfd full scale, depending on frequency)

Front Panel Plug-In Module

Standard plug-in module (Model 100-PA-1001) covers ranges shown. Special modules available for special applications.

Frequency Range

100 cps to 200 kcps

Accuracy

(1) Basic Instrument Accuracy
Better than ±2% full scale vector amplitude accuracy; better than ±2-1/2° vector phase accuracy from 100 cps to 150 kcps; better than 5° phase accuracy to 200 kcps.

(2) Accuracy Limitations Imposed by Impedometer-Admittometer Input Circuits of Standard Plug-in.

(a) Vector amplitude: Better than ±2% full scale up to 100 kcps for ranges of 10K or less. Accuracy decreases with increased frequencies and increased ranges to a limit of ±10% full scale at 200 kcps on 50, 000 scale.

(b) Vector Phase: Better than ±2-1/2° up to 80 kcps for ranges of 10K or less. Accuracy decreases with increased frequencies and increased ranges. At 150 kcps and 25K, the phase error is less than 10°.

Table 1-1. Specifications for Model 100B (cont)

Voltage Across Unknown

Y Measurement - 3 volts rms
Z Measurement - less than 30 mv rms

Unknown Terminals

Impedance - 3 terminals, Low (gnd), High, and Guard

Admittance - 3 terminals, Low (connected to ground through power oscillator output), High and Guard.

Calibration Reference

Internal precision transfer standard

Output Filters (Each Output)

With Panel Switch in NORMAL, Rise time (0-90%)-approx. 85 ms
With Panel Switch in FAST, Rise time approx. 30 ms

Data Presentation

Panel Meters: Two 4 inch precision mirror scale meters for direct reading of R and X or G and B. Quadrature meter indicates sign of quadrature.

Output Terminals: Two sets of output terminals, each producing 0.8 volt d.c. full scale minimum for X-Y recorder, oscilloscope or strip chart recorder.

Output Scaler

Front panel output switches provide independent scaling of X and Y outputs of 0, 50% and 100% of full scale for convenient [illegible] setting of X-Y recorder.

Table 1-1. Specifications for Model 100B (cont)

Power Emitter Follower

(1) Output impedance of E.F.-approx. 2 ohms

(2) Load impedance limit-will drive loads as low as 100 ohms. For measurements of admittances greater than 5000 micromhos, external oscillator and amplifier must be used. Front panel jacks provided for external oscillator and amplifier.

(3) Output level-3 volts rms (indicated on AC expanded scale voltmeter)

Input Power

105-125 volts. 60 cps, 25 watts max (Electrical circuit grounded through third wire of three wire power cable.)

Mechanical

Entire unit self contained in walnut carrying case 14" x 14" x 12" max. Carrying weight - 25 pounds maximum.

Serial Numbers

Serial numbers are assigned to the main assembly and to each plug-in module. The main assembly serial number appears internally on the rear panel and can be seen by removing the Impedometer-Admittometer plug-in. Serial numbers for all modules are printed on the outside of each module.

The following serial numbers apply to this instrument:

Main Assembly B100,035	Serial No. _____
D-C Power Supply B100,038	Serial No. _____
[illegible] Shift Network B100,037	Serial No. _____
Power Emitter Follower B100,036	Serial No. _____
Blanking Amplifiers B100,039	Serial No. _____
Z-Y Amplifier and Limit Relay	Serial No. _____
Quadrature Resolver B100,042	Serial No. _____
In-phase Resolver B100,609	Serial No. _____
Impedometer-Admittometer Plug-in Mod. 100PA100__	Serial No. _____

SECTION II

OPERATION

2-1 FUNCTIONS OF CONTROLS, INDICATORS AND TERMINALS

Table 2-1 lists the functions of controls, indicators and terminals for the Complex Impedance-Admittance Meter Model 100B with Model 100-[illegible]-1001 plug-in module. Refer to figure 2-1 for the identification of all controls, indicators and terminals.

Table 2-1. Functions of Controls, Indicators and Terminals

INDEX NO.	CONTROL, INDICATOR OR TERMINAL	FUNCTION
9	"on-off" switch	Applies main power.
10	115-Volt 60-cps A-C power receptacle	Three-wire single phase A-C input (includes one ground terminal).
12	1/4 Ampere Slo-Blo fuse	Buss AGX-1/4 AMP for A-C input circuit.
13	Indicator (red)	Indicates application of 115-volt 60-cps power.
16	EXT. OSC. Two 5-way binding terminals (black and red)	For connection of external oscillator for all impedance ranges and admittance ranges up to and including 5000 micromhos.
15	EXT. AMP. Two 5-way binding terminals (black and red)	For connection of external amplifier. External amplifier must be used for measuring admittances greater than 5000 micromhos.
14	INPUT SELECT switch OSC. - AMP.	A 2-position switch which selects external oscillator or amplifier input.
17	FREQ. RANGE switch 0.1 - 2KC 1 - 20KC 10 - 200KC	Selects operating frequency range of the instrument.

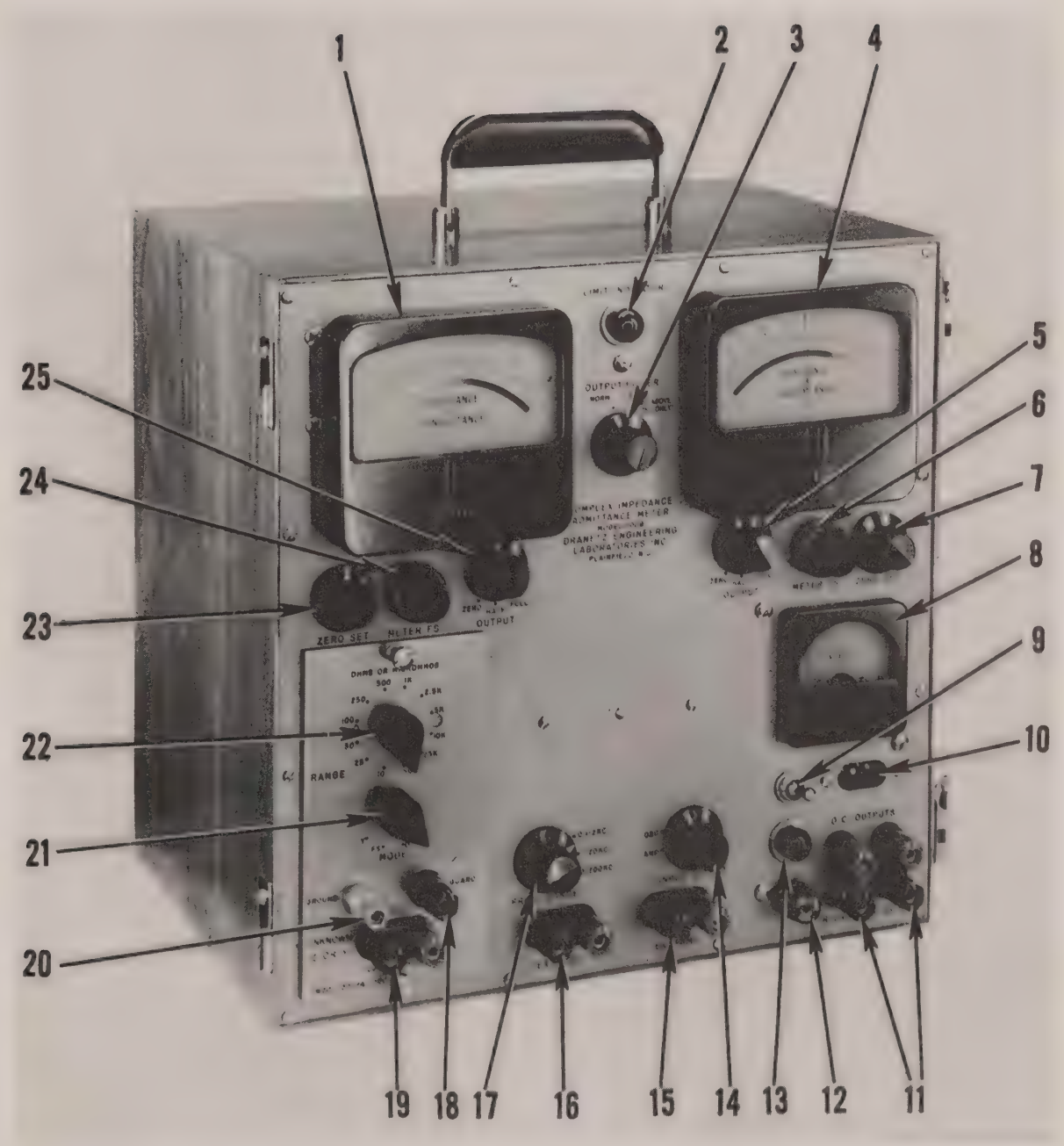


Figure 2-1. Complex Impedance-Admittance Meter Model 100B, Front Panel

Table 2-1. Functions of Controls, Indicators and Terminals (cont)

INDEX NO.	CONTROL, INDICATOR OR TERMINAL	FUNCTION
11	D. C. OUTPUTS Two pairs of 5-way terminals (black and red)	One pair of terminals for D-C output voltage proportional to resistance or conductance (R or G respectively). One pair of terminals for D-C output voltage proportional to reactance or susceptance (X or B respectively). NOTE For connection to external recording instruments, black terminals are internally connected to circuit ground; red is high side.
8	A-C expanded scale voltmeter (rms)	Monitors voltage level of signal applied to impedometer-admittometer network. For all measurements, signal voltage should be set to 3 volts rms and maintained throughout precalibration and operational measurements. CAUTION Waveform of input signal should be free of harmonic distortion. Do not apply voltages in excess of 3.5 volts rms.
1	RESISTANCE or CONDUCTANCE meter	A 4-inch mirror scale linear meter which reads resistance or conductance. Meter scale corresponds to RANGE switch positions.
4	REACTANCE or SUSCEPTANCE meter	A 4-inch mirror scale linear meter which reads reactance or susceptance. Meter scale corresponds to RANGE switch positions.
23 7	ZERO SET controls (resistance or conductance) (reactance or susceptance)	One control each for resistance or conductance and reactance or susceptance for adjustment of meter zero indications with mode switch on Calibrate - O. (Simultaneously adjusts zero level D-C outputs.)
6 24	METER FS controls (reactance or susceptance) (resistance or conductance)	Locking control for adjustment of meter full scale readings. These controls adjust the sensitivities of the meters and do not effect the D-C output levels.

Table 2-1. Functions of Controls, Indicators and Terminals (cont)

INDEX NO.	CONTROL, INDICATOR OR TERMINAL	FUNCTION
2, 5	OUTPUT switches ZERO - HALF - FULL (resistance or conductance), (reactance or susceptance)	One for each of the two D-C outputs. Attenuates the output by zero (FULL), 50% (HALF) or 100% (ZERO position).
3	OUTPUT FILTER switch NORM. - FAST (USE ABOVE 2KC ONLY)	In FAST position, the output filter is changed to provide a rise time of 85 milliseconds. In addition, high-pass filters are inserted in the signal circuits throughout the instrument to attenuate frequencies below 2 kilocycles. NORM position contains a low-pass filter with a rise time of 85 milliseconds. The filter is located in the output of each of the resolver circuits.
2	LIMIT INDICATOR	Indicates when the unknown impedance or admittance is substantially greater than the full scale setting. Simultaneously with the turning on of the indicator light, an internal relay shunts the meters and the D-C output terminals to zero. NOTE During operation, proceed to higher full scale of RANGE switch until indicator lamp does not light.
	Located on plug-in Model 1000-P11-1000	
19	UNKNOWN Z OR Y terminals LOW (black) - HIGH (red)	Five-way terminals for connection to device being measured. Note: For impedance measurement, black is ground and red is high side. For admittance measurement, both terminals are ungrounded. (See paragraph 2-6 for use.)
18	GUARD terminal	A special connection for a driven shield with minimum capacitive loading of the unknown device.

Table 2-1. Functions of Controls, Indicators and Terminals (cont)

INDEX NO.	CONTROL, INDICATOR OR TERMINAL	FUNCTION
	Located on plug-in Model 100-PA-1001	
20	GROUND terminal	Alternate ground connection. CAUTION Operator should use either this GROUND terminal or alternate ground through power cable but not both simultaneously. This is done to avoid ground loops.
21	MODE 4-position switch Y - FS - O - Z	Selects precalibration and operation modes. Y - Admittance. FS and O - Adjustment for calibration of zero and full scale positions only. Precalibration holds for any amplitude range of impedance or admittance. Z - Impedance.
22	RANGE switch OHMS OR MICROMHOS 12 positions: 10 - 25 - 50 - 100 - 250 - 500 - 1K - 2.5K - 5K - 10K - 25K - 50K	Presets full-scale ranges for admittance and impedance. Impedance is indicated in series resistance or reactance. Admittance is indicated in parallel conductance and susceptance.

2-2 OPERATING PROCEDURE

CAUTION

DO NOT APPLY D-C VOLTAGES TO
ANY TERMINAL ON THE FRONT PANEL.

2-3 Presetting and Connection Procedure

a. Plug the power cord into a 3-terminal 115 volt 60 cps outlet. The instrument can be grounded by the third wire of the power cable; however the instrument should be grounded at only one point. If the ground terminal on the plug-in unit is to be used as the ground, the ground on the power cable should NOT be used; in this case, use a 3-pin-to-2-pin adapter in plugging the power cable into an appropriate outlet.

2-3 Presetting and Connection Procedure (cont)

NOTE

An internal fuse is provided in the event that a voltage is inadverdently applied between these two ground points. If during operation, it is suspected that the third wire of the power cable is open-circuited and does not provide a ground, this fuse should be checked. (The fuse (F2) is located inside the instrument on the rear panel.)

b. Connect an external oscillator having maximum of 3.5 volts rms output to EXT. OSC. terminals. If admittance measurements are to be made on an unknown having an admittance of more than 5000 micromhos, connect the output of the external oscillator to the input of an external power amplifier and connect the output of the power amplifier to EXT. AMP. terminals.

CAUTION

MAKE SURE THAT THE POWER AMPLIFIER DOES NOT APPLY MORE THAN 3.5 VOLTS RMS TO THIS INSTRUMENT. EXCESSIVE VOLTAGE MAY BLOW A FUSE (F3) LOCATED IN THE REAR OF THE INSTRUMENT AND/OR CAUSE PERMANENT DAMAGE.

The power amplifier must have sufficiently low output impedance so that frequency dependence of the unknown impedance will not change the output level of the power amplifier.

CAUTION

DO NOT CONNECT D-C VOLTAGE
TO THESE TERMINALS.

c. Set controls as follows:

(1) RANGE switch to 50K.
(2) MODE switch to calibrate 0 position.
(3) FILTER switch to NORMAL.
(4) FREQUENCY switch to desired frequency range.
(5) INPUT SELECT switch to either EXT. OSC. or EXT. AMP., depending on intended use.
(6) Both OUTPUT switches to ZERO.
(7) Set external oscillator and/or amplifier output gain controls for zero output.
(8) Set oscillator control to a frequency in the vicinity of intended measurements.

2-4 System Turn-On Procedure

a. Snap front panel toggle of CIAM-100B to right, at which time the red pilot lamp will light.

b. Turn on power oscillator (and power amplifier if used) and adjust the gain control until the A-C Voltmeter on the CIAM-100B reads precisely 3 volts rms.

NOTE

While the system is ready for use IMMEDIATELY after application of power, a warm-up period of 1/2 hour is recommended to stabilize zener diodes used in the equipment. The equipment may be left ON continuously. Since the internal gating circuits require an input sine wave for control, the external oscillator should be turned on whenever the CIAM is turned on. Otherwise, loss of switching control may result in a very low frequency oscillation of output voltage, as evidenced by motion of the panel meters.

2-5 Precalibration Procedure

a. Check to insure that input signal level is precisely 3 volts rms and remains at this level throughout precalibration and measurement.

b. With MODE switch in calibrate 0 position, adjust left ZERO SET control until pointer on RESISTANCE or CONDUCTANCE meter reads ZERO (left end of scale).

c. Repeat b. above with right ZERO SET control until REACTANCE or SUSCEPTANCE meter reads at center of scale.

d. Turn MODE switch to calibrate FS.

e. Adjust left METER FS control until pointer on RESISTANCE or CONDUCTANCE meter reads at full-scale to right (right end of scale).

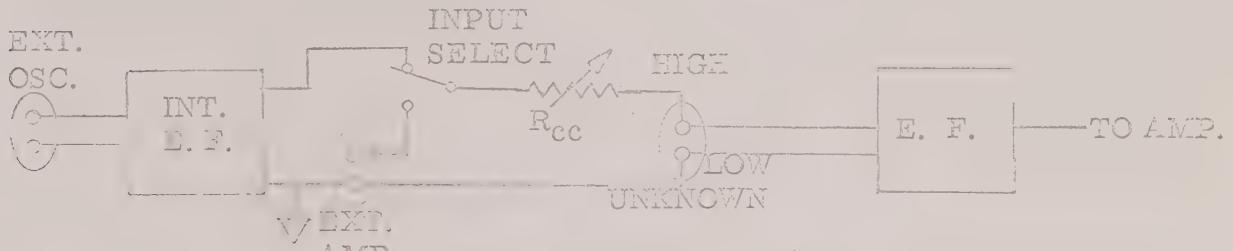
f. Adjust right METER FS control until pointer on REACTANCE or SUSCEPTANCE meter reads at negative full scale (left end of scale).

NOTE

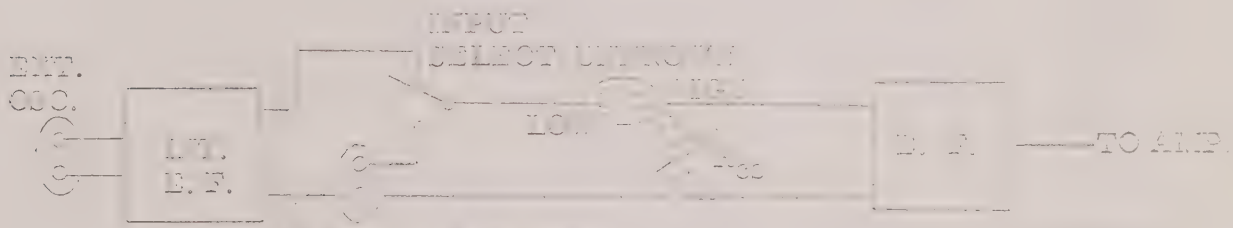
The METER FS controls merely adjust the meter sensitivities and do not change the values of a-c outputs.

g. The instrument is now ready for operation.

a. Connect the unknown impedance to the UNKNOWN terminals, observing LOW and HIGH terminal designations. The following diagrams show how connections are made internally (in the standard Impedometer-Admittometer plug-in module).



Impedance Connection (R_{cc} is constant current resistor.)



Admittance Connection (R_{cs} is current [illegible] resistor.)

In the impedance connection (MODE switch in Z), the unknown is grounded, the LOW terminal of the UNKNOWN pair being the ground terminal. In the admittance connection, the unknown is ungrounded. Note that the LOW terminal is actually connected to the high side of the signal source. This has been done because the source impedance of the internal emitter-follower (approximately 2 ohms when the load is above 200 ohms) or an external amplifier, will always be low while the resistance R_{cs} may be as high as 1000 ohms (for the 10-micromho scale). Thus, the LOW terminal designation refers to "low impedance to ground" rather than low voltage as might otherwise be interpreted.

CAUTION

Since high voltage may damage the semiconductor circuits, two precautions should be taken before connection of an unknown. First, if the unknown has a d-c path from a d-c voltage source to the measurement terminals, the d-c path should be blocked by a capacitor, transformer, or other means. Second, in the case of dielectric components or piezoelectric devices, which might retain an electrical charge, such a unit should be shorted momentarily before connection to this instrument. Particular attention should be given to the generation of charge during polarization relaxation (soon after polarizing) or due to pyroelectric effects.

2-6 Measurement (cont)

b. Turn the MODE switch to the Y (for admittance) or Z (for impedance) to operate. With the MODE switch in the Y position, the meters read directly in equivalent parallel conductance and susceptance. In the Z position, the meters read in equivalent series resistance and reactance. The quadrature component meter indicates the sign of the component.

NOTE

The resistance meter may be used to read negative resistance by displacing the pointer during the calibrate 0 operation above.

c. Scan the frequency range by means of the variable frequency oscillator noting whether the RANGE switch is set properly (at 50K) or at too high a position. Set the RANGE switch to the best position (noting that the LIMIT INDICATOR lamp will light if the meters read off scale by a substantial amount).

NOTE

If the LIMIT INDICATOR lamp lights, check the following:
(a) If the MODE switch is in Z position, the light may indicate an open circuit in the "unknown".
(b) With the MODE switch in the Y position, the light may indicate a short circuit in the "unknown".
(c) With the MODE switch in either position, it may indicate the presence of 60 cps or other unwanted signal across the input.

If the LIMIT INDICATOR lamp remains on for all ranges, check using an oscilloscope from the HIGH unknown terminal to ground. If 60 cps signal is present, shield the cable to the "unknown" and connect the shield to the GUARD terminal. If the frequency of interest is above 2 KC, turn the FILTER switch to FAST position.

d. Quickly check the precalibration at a frequency in the vicinity of interest.

e. Set the oscillator to the frequencies of interest and at each frequency, read the two components of impedance or admittance, checking to insure that the input voltage level is held constant at each frequency.

2-7 Use of External Recorder or Indicators

a. For obtaining impedance or admittance plane plots, utilize an oscilloscope or plotter having provision for d-c inputs on both the horizontal and vertical axes. On both axes, the sensitivities should be variable, being at least full scale for an input of 0.8 volts dc.

CAUTION

Do not connect any device which has d-c voltage present on its input terminals.

b. Connect the horizontal axis input of the indicator to the R or G output terminals of the CIAM-100B and the vertical axis input of the indicator to the X or B terminals, observing that the black output terminals are grounded.

NOTE

When using an external recording instrument with the CIAM-100B, the circuits of the recorder are grounded through the output terminal of the CIAM-100B. DO NOT CONNECT OTHER GROUNDS TO THESE CIRCUITS.

c. Determine the desired graph size and locate the desired positions of horizontal and vertical origins and full scales.

d. Turn on the recording instrument.

e. On the CIAM-100B, turn both OUTPUT switches to FULL.

f. Turn the MODE switch to calibrate 0.

g. Check to see if both panel meters read zero. If not readjust ZERO SET controls as necessary.

h. Adjust the zeroing controls on the external recording instrument (oscilloscope or recorder) until the dot or pen appears at the intersection of the horizontal and vertical axis.

i. On the CIAM-100B, turn the MODE switch to calibrate FS position.

j. Adjust the horizontal and vertical gains of the external indicating instrument to full scale on the horizontal axis and negative full scale on the vertical axis.
(NOTE: For set-up convenience, the two d-c outputs of the CIAM-100B may be switched independently to ZERO, HALF or FULL scale by use of the OUTPUT switches.

2-7 Use of External Recorder or Indicators (cont)

k. Switch the MODE switch on the CIAM-100B to either Z or Y.

l. If a pen recorder is used, do not allow the pen to engage the paper until the set-up procedure is completed and the system is ready for actual recording.

m. Engage the pen and scan the frequency slowly through the band of interest, recording desired pattern.

n. If a pen recorder is used, disengage the pen from the paper immediately after drawing the continuous curve. The curve may be labeled at specific frequencies by setting frequency to values of interest after the curve is drawn, and with pen "hovering" above the paper.

o. For impedances (or admittances) having one component much larger than the other, the appropriate zero control on the recorder may be adjusted for zero offset, then both gains increased to expand the tracing. This can also be accomplished by setting up the recorder full scales using the CIAM-100B OUTPUT switches in the HALF position. After offsetting the appropriate zero of the recorder, these OUTPUT switches may be turned to the FULL position to double the output voltage. In both examples described above, the panel meters will read directly so that the extent of zero shift is known at all times.

p. After measurement of an unknown, it is recommended that the MODE switch be turned to calibrate 0 and the OUTPUT switches turned to ZERO. If the MODE switch is in the Z position when the unknown is removed, the LIMIT INDICATOR will light, and a relay will short out the meters and the D-C OUTPUT terminals.

SECTION III

PRINCIPLES OF OPERATION

3-1 COMPLEX IMPEDANCE-ADMITTANCE METER FUNCTIONAL DISCUSSION

3-2 A block diagram describing the operating principles of the Complex Impedance-Admittance Meter is shown in figure 3-1.

3-3 A sine wave of 3 volts rms from the internal oscillator or an optional external source is impressed on the input of the Impedometer-Admittometer plug-in module where it is distributed directly to three points (1) directly into the Impedometer-Admittometer circuits, (2) back out to a squaring amplifier, and (3) back out to a 90° phase shift network.

The signal within the plug-in module in conjunction with internal circuitry, results in a plug-in output voltage having an amplitude proportional to either impedance or admittance of the unknown, and having a phase shift equal to the phase of the unknown impedance or admittance. The explanation of how this is accomplished is described in another section. This signal is amplified to a level of approximately 1 volt rms corresponding to any full scale of impedance and/or admittance. Thus the output of the I-F amplifier is a sine wave having amplitude and phase corresponding to the amplitude and phase of the unknown being measured.

The 3-volt signals coming back out of the Impedometer-Admittometer plug-in module are used for phase reference. One signal is applied to a squaring amplifier, producing a square wave having the same zero crossing times as the original input sine wave. The second signal is applied to a 90° phase shift network, and then to a squaring amplifier which produces a square wave having zero crossings 90° out of phase with those of the original sine wave.

The resolvers are basically electronic switches and integrating circuits. The switches are held "on" during the positive portion of the square wave, allowing the signal from the amplifier to pass during this time. During the negative square wave voltage the switches are turned off. Typical outputs from the switches are shown in figure 3-2.

The average value of a d-c output is zero when the signal and square wave are 90° out of phase and is a maximum positive when the two voltages are in phase and a maximum negative when the voltages are 180° out of phase. It can be shown that the average d-c output is given by

$$V_{dc} = A|V|\cos\gamma$$

where $|V|$ is the amplitude of sine wave into the switch, and
γ is the angle between zero cross-over of the sine and square waves.

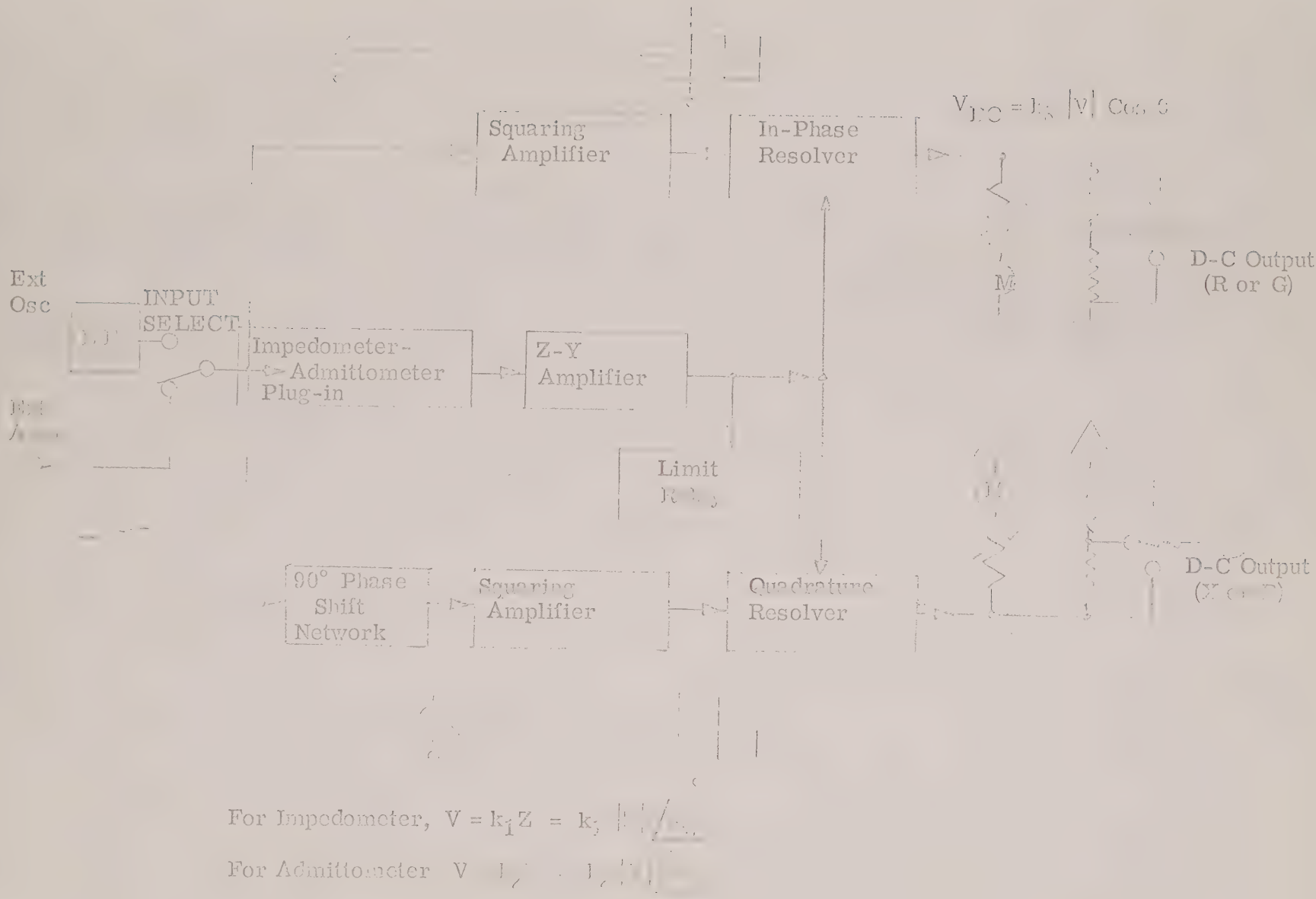


Figure 3-1. Complex Impedance-Admittance Meter, Block Diagram

The in-phase resolver is switched by the square wave formed directly from the reference 3-volt signal. Thus, the d-c voltage output of this resolver is proportional to the in-phase component of voltage output of the impedometer-admittometer circuits.

The quadrature resolver is switched by a square wave which has been shifted 90° in phase from the reference. Thus, the d-c output is proportional to the quadrature component of voltage output of the impedometer-admittometer circuits. It should be noted that the d-c outputs may be either negative or positive; hence, the equipment may measure negative impedances or negative admittances.

The d-c outputs are connected to the control panel for meter adjustments. The first meter provides a direct reading of resistance or conductance in the parallel mode and of resistance or voltage in the series mode. Two terminals, connected through 3-position switches are provided for connection to recording or other indicating instruments. The output switches attenuate each of the outputs for ease in setting up external recorders.

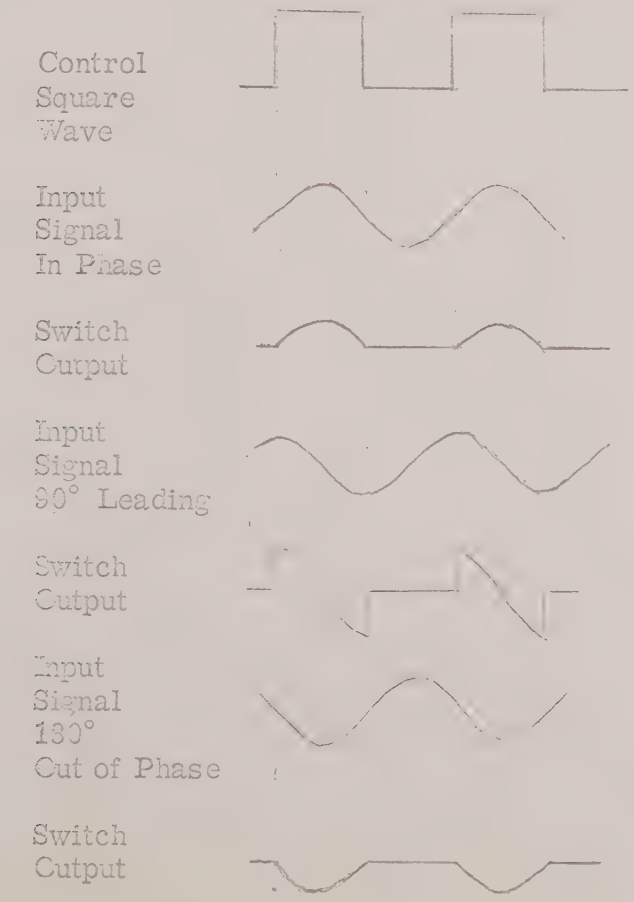


Figure 3-2. Typical Input Signal and Output Waveforms

3-1 STANDARD IMPEDOMETER-ADMITTOMETER PLUG-IN MODEL 100-PA-1001

3-3 The Model 100 Complex Impedance-Admittance [illegible] is provided as a standard plug-in module for both impedance and admittance measurements. Internal wiring of the system includes a number of [illegible] to the plug-in adapter for accommodating other special plug-in units. The standard plug-in module performs three functions as shown in the schematic diagrams (figures 3-3, 3-4, 3-5, 3-6 and 3-7).

3-5 Precalibrate Function

a. Calibrate Zero

With the MODE switch in the calibrate [illegible] position, [illegible] is applied to the self-contained emitter follower [illegible] This provides a reference for zero d-c [illegible]

Figure 3-3. Calibrate Zero, Schematic Diagram

b. Calibrate FS

With the MODE switch in the calibrate FS position, the input [illegible] attenuated by precisely 100, and the output voltage is fed to both in-phase and quadrature resolvers (the 90° phase shift network is removed) to provide full scale indications. Since the information of 100 corresponds to any full scale output, the meter and external indicator's full scale sensitivities may be adjusted under these conditions.

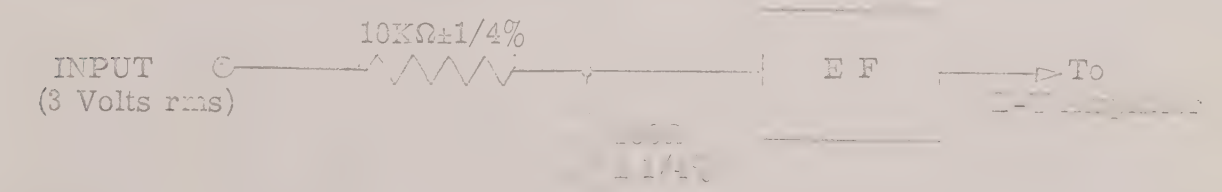


Figure 3-4. Calibrate FS, Schematic Diagram

3-7 Impedance Measurement

In the Z position of the MODE switch, one of 12 precision constant current resistors R_Z is placed in series with the unknown, each constant current resistor being 100 times the full scale value of unknown impedance (except for 10K, 25K and 50K ohm positions where the resistor is maintained at 500K ohms). Thus, the output is proportional to the amplitude of unknown impedance, having a phase equal to the phase angle of the impedance. A schematic diagram of the circuit when the Range switch in positions from 10 ohms to 5K ohms is shown in figure 3-5.

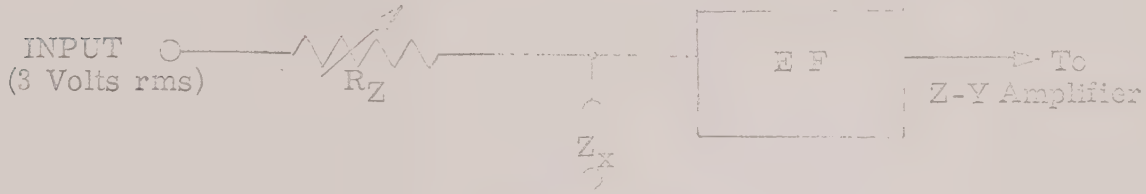


Figure 3-5. Impedance Measurement for Ranges of 10 Ohms Through 5K Ohms, Schematic Diagram

To minimize the effects of shunt capacitance across the constant current resistor at high frequencies, the largest constant current resistor used is 500K ohms. This fixed value is used for RANGE switch positions 5K ohms, 10K ohms, 25K ohms and 50K ohms. In order to maintain this resistance constant for [illegible] reduce the input voltage for the higher impedances. This is shown in the schematic diagram, figure 3-6.

[illegible] considered entirely constant, since the unknown [illegible] appreciable value compared to R_Z. [illegible] the operator should check by use of the admittance mode.

If high impedance measurements are required at lower frequencies, the [illegible] provided to maintain the constant current resistor at least 100 times the unknown for all ranges.

3-7 Impedance Measurement (cont)

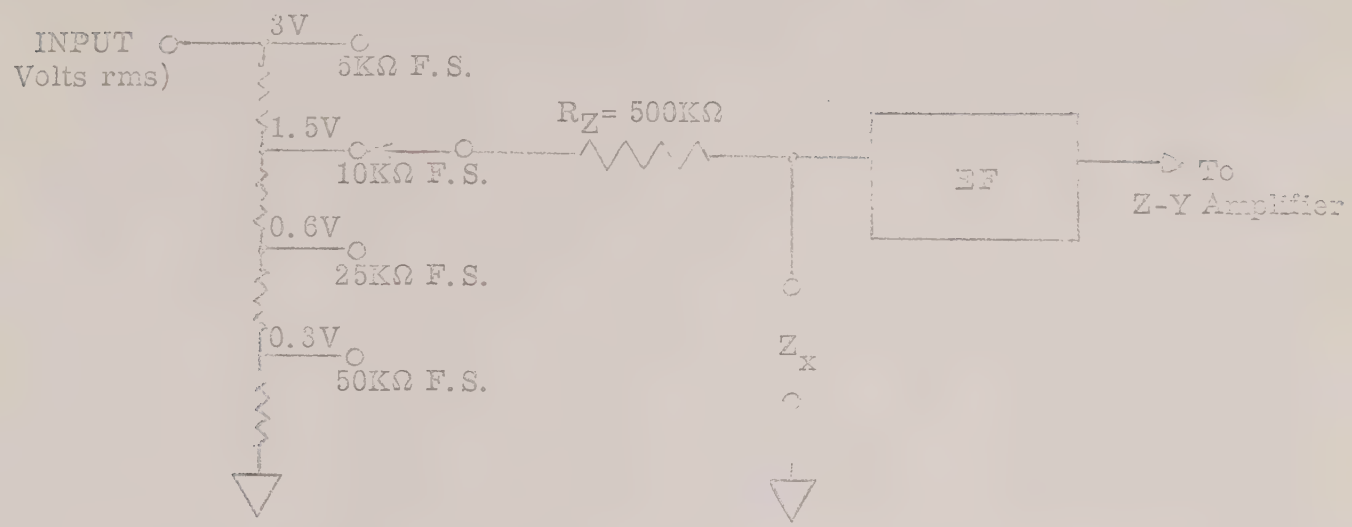


Figure 3-6. Impedance Measurement for Full Scale Ranges of 5KΩ, 10KΩ, 25KΩ and 50KΩ, Schematic Diagram

3-8 Admittance Measurement (See figure 3-7.)

In this measurement, the resistor in series with the unknown is grounded [illegible] is much smaller than the value of the unknown impedance. Hence, the entire 3-volt signal is [illegible] across R_{xy}, proportional to and in phase with the current, is proportional to the amplitude of [illegible] unknown admittance. The admittance circuit arrangement of this plug-in, because it utilizes the output of a grounded emitter follower as a signal source, requires that the unknown admittance be maintained off ground. [illegible] made for testing grounded admittances if other plug-in modules are used.

Figure 3-7. Admittance Measurement, Schematic Diagram

MAINTENANCE

4-1 [illegible]

4-2 This section contains the information necessary for troubleshooting the Complex Impedance-Admittance Meter. The troubleshooting procedures for this equipment are designed to [illegible] major circuit subdivisions. These procedures utilize [illegible] tracing method of trouble analysis. With this method, operating conditions are maintained and indications in the signal path are observed.

4-3 Schematic diagrams of the front panel showing [illegible] the rear panel showing all plug-in connectors with signal and [illegible] data are included. (See drawings Nos. 100,042 and 100,043.)

4-4 TROUBLESHOOTING PROCEDURE

4-5 The Complex Impedance-Admittance Meter [illegible] throughout for ease of maintenance. A test adapter, mounted [illegible] rear of the main chassis inside the carrying case, is provided to simplify troubleshooting. The test adapter can be inserted between internal plug-in modules and the main chassis for exposing the plug-in terminal connections. All troubles are isolated with conventional test equipment.

4-6 Table 4-1 is a trouble analysis chart that describes the trouble-shooting procedures that can be performed to locate defective plug-in modules (figure 4-1). The equipment should be set up for normal operation observing all precautions noted in the operating procedure, Section II.

4-7 The Complex Impedance-Admittance Meter includes the following plug-in modules:

[illegible] sembly
[illegible] Regulator
[illegible] hase Shift Network
[illegible] Emitter Follower
[illegible] ing Amplifier
[illegible] lifier and [illegible]
Quadrature Resolver
In-Phase Resolver
[illegible]

Whenever maintenance of a plug-in module is required, it should be returned to Dranetz Engineering Laboratories, Inc.

4-1

SQUARE WAVE AMPLIFIER

D-C REGULATOR

Z-Y [illegible] AMPLIFIER AND LIMIT RELAY

90° PHASE SHIFT NETWORK

POWER EMITTER FOLLOWER

Figure 5-2
Plug-In Modules, Location Diagram

Table 4-1 Complex Impedance-Admittance Meter, Trouble Analysis Chart

	INSTRUCTIONS	[illegible]	PROBABLE [illegible] ABNORMAL [illegible]
	NOTE All of the following checks are performed with the equipment set up for normal operation. (See paragraphs 2-2 through 2-5, Section II.) The following checks require an external amplifier with a maximum of 4 ohms source impedance and capable of delivering a 3-volt rms undistorted signal at 2 watts power. Operate equipment at 1 Kc with the OUTPUT FILTER switch in NORM position		
1	Connect test adapter between connector J6 and D-C Regulator and measure voltages at terminals. NOTE All voltage measurements are made using a VTVM. Connect ground terminal of VTVM to GROUND terminal on front panel of Impedometer-Admittometer plug-in.	Pin / Volts DC 1 / +22.5 7 / - 6.2 9 / - 2.0 16 / -17.0 18 / +27.0	Defective D-C Regulator, or if voltages are incorrect, proceed with step 2
2	Remove Impedometer-Admittometer plug-in. (Leave load.) Connect [illegible] approximately across pins 1 [illegible] Measure voltages between J6 terminals and the respective ground for each voltage source: a. between pins 1 and 5 b. between pins 7 and 5 c. between pins 9 and 5 d. between pins 16 and 11 e. between pins 18 and 12	Pin / Volts DC 1 / +22.5 7 / - 6.5 9 / - 2.4 16 / -20.0 18 / +27.0	If all voltages are present, remove one plug-in module at a time to isolate shorted module. If -20 vdc and/or +27 vdc are not present, defective Rectifier Filter. If individual outputs are incorrect, defective D-C Regulator. [illegible] with step 3.

Table 4-1 Complex Impedance-Admittance Meter, Trouble Analysis Chart (cont)

	INSTRUCTIONS		
3	Measure a-c input at pins 1 and 13 of connector J7.	115 VAC	Defective connections or "on-off" switch.
4	Connect unit for normal operation with Impedometer-Admittometer plugged in. Set INPUT SELECT switch to OSC position and observe A-C voltmeter.	3 VAC	[illegible] Power Follower.
	Connect external oscillator and external amplifier to EXT. AMP. terminals. Adjust output of power amplifier as specified in paragraph 2-3. Observe A-C voltmeter.	3 VAC	
5	Connect test adapter between connector J2 and Z-Y Amplifier and Limit Relay. Connect an oscilloscope and an HP400H VTVM or equivalent between pin 7 of J2 and ground.		
	Set MODE switch to calibrate 0 position and observe indicators.	Less than 1 mv random noise pattern.	[illegible]
	Set MODE switch to calibrate FS and observe A-C output.	30 Mv.	Defective Impedometer-Admittometer plug-in.
6	Connect a decade box across UNKNOWN terminals to supply a range of resistances of at least 1% accuracy: 10, 25, 50, 100, 250, 500, 1K, 2.5K, 5K, 10K, 25K and 50K. NOTE Unknown resistance should be equal to setting of controls on front panel.		
	Set MODE switch to Z and measure A-C output for each resistance.	30 mv rms undistorted sine wave.	Defective Impedometer-Admittometer [illegible]

Table 4-1 Complex Impedance-Admittance Meter, Trouble Analysis Chart (cont)

	INSTRUCTIONS		
7	Set MODE switch to Y and measure A-C output for each of the following resistances. Set RANGE control setting to correspond to the following resistance values: NOTE Decade box must be ungrounded for the admittance checks. RANGE control setting — Resistance on UNKNOWN terminal 10 — 100K 25 — 40K 50 — 20K 100 — 10K 250 — 4K 500 — 2K 1K — 1K 2.5K — 400 5K — 200 10K* — 100* 25K* — 40* 50K* — 20* * Connect external amplifier for these checks.	50mv rms undistorted sine wave.	Defective Impedometer-Admittometer plug-in.
8	Connect test adapter between connector J3 and Squaring Amplifier. Connect VTVM to measure output at pin 7 of J3. Place a 100-ohm resitor across UNKNOWN terminals. Set MODE switch at Z and RANGE switch at 100 ohms. Measure A-C voltage [illegible] for the following conditions: (a) With FREQ RANGE switch at 0.1 - 2KC, measure output at 100-cps and 2-kc inputs.	45 mv ± 10 mv	Defective 90° Phase Shift Network.
	(b) With FREQ RANGE switch at 1 - 20 KC, measure output at 1-kc and 20-kc inputs.	[illegible] ± 10 mv	
	(c) With FREQ RANGE switch at 10 - 200 KC, measure output at 10-kc and 200-kc inputs.	[illegible] ± 10 mv	

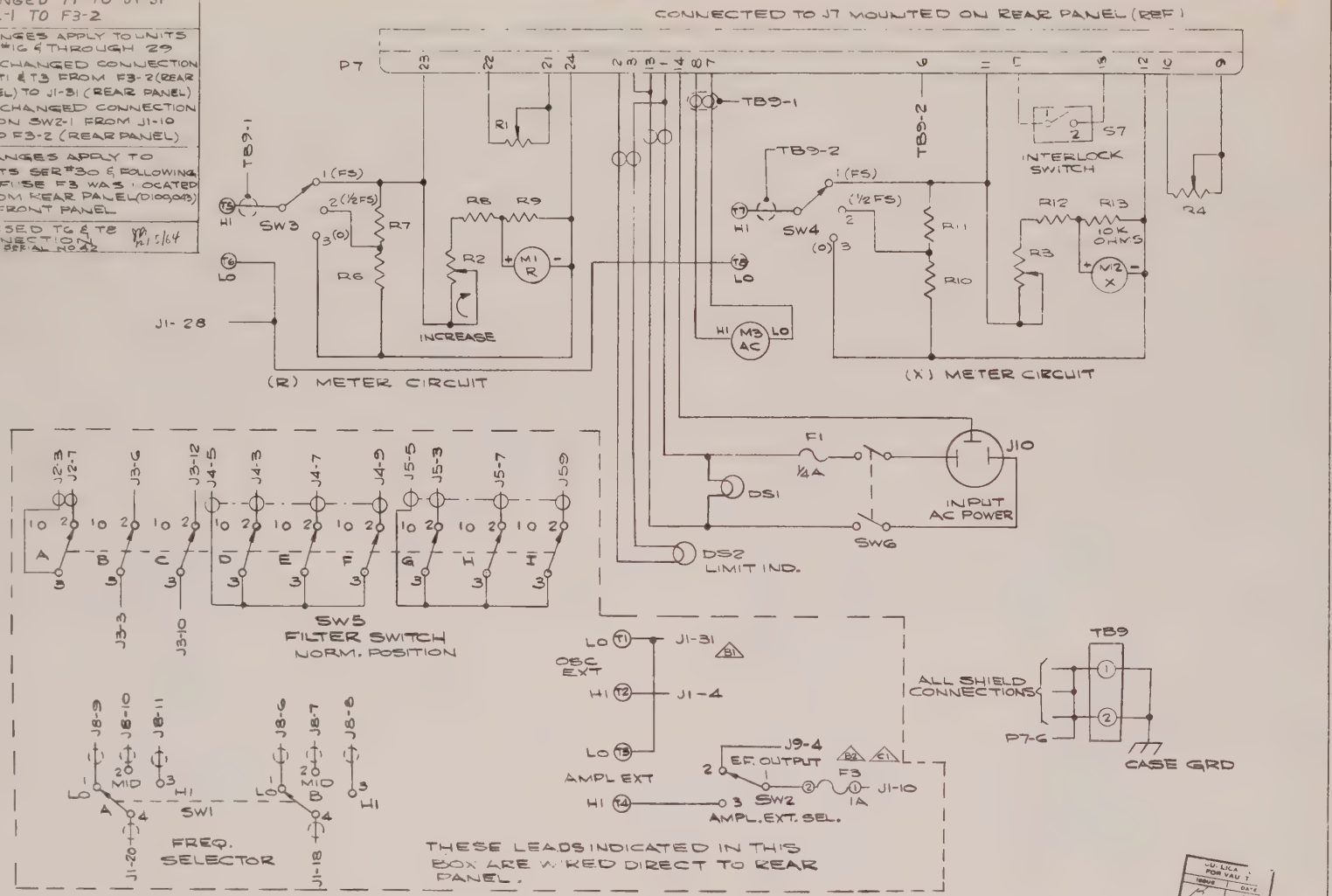
Table 4-1 Complex Impedance-Admittance Meter, Trouble Analysis Chart (cont.)

STEP	INSTRUCTIONS	NORMAL INDICATION	PROBABLE CAUSE OF ABNORMAL INDICATION
9	Connect test adapter between connector J2 and Z-Y Amplifier and Limit Relay. Set MODE switch to calibrate FS and measure A-C voltage with VTVM at pin 7 and pin 11 of J2.	Input of 30 mv at pin 7. Output of 0.75 volts at pin 11.	See Step 5
10	Connect a 500-ohm variable resistor across UNKNOWN terminals, set MODE switch to Z and RANGE control setting to 100 ohms. Vary resistor and observe A-C voltage at pin 11 of J2.	Limit Relay should operate at 1.8 volts (limit indicator lights) and should reset at approximately 1.3 volts (limit indicator goes out).	Defective Z-Y Amplifier and Limit Relay.
11	Connect test adapter between connector J3 and Squaring Amplifier. Set FREQ RANGE switch to 0.1 - 2KC position. Set external oscillator to 1 KC, and check a-c input voltage to pin 1 of J3.	Approximately 40 mv input.	See Step 6
	Using Tektronix 535 oscilloscope or equivalent, observe waveforms at pins 13 and 17 of J3.	[illegible]	[illegible]
[illegible]	[illegible] Set MODE switch to calibrate C. Observe waveform at pin 13 of J3 and measure d-c voltage with VTVM at pin [illegible] of J3.	[illegible] with zero set pot. adjusted. [illegible]	[illegible] In-Phase Resolver.

Table 4-1 Complex Impedance-Admittance [illegible]

		ABNORMAL INDICATION
1) [illegible]	[illegible]	Defective In-phase Resolver.
2) [illegible]	[illegible]	Defective Quadrature Resolver.
3) [illegible]	[illegible]	

ISSUE	REV.
A	CHANGED T1 TO J1-31 - SW2-1 TO F3-2
B	CHANGES APPLY TO UNITS SER #16 & THROUGH 29 B-1 CHANGED CONNECTION ON T1 & T3 FROM F3-2 (REAR PANEL) TO J1-31 (REAR PANEL) B-2 CHANGED CONNECTION ON SW2-1 FROM J1-10 TO F3-2 (REAR PANEL)
C	CHANGES APPLY TO UNITS SER #30 & FOLLOWING C-1 FUSE F3 WAS LOCATED FROM REAR PANEL (D100,043) TO FRONT PANEL
D	REVISED TG & TB CONNECTIONS REF. DRAWING NO. 42



NOTE:
FOR REAR PANEL WIRING DIAGRAM SEE DWG D100,043

△ INDICATES CHANGES REVISION LETTER SEE BOX FOR INFORMATION

LEGEND
INDICATES 4 TWISTED WIRES

DRANETZ ENGINEERING LABS INC.
11 WASHINGTON AVENUE, PLAINFIELD N.J.

SCHEMATIC WIRING DIAGRAM
FRONT PANEL MOD 10CB

DWG. BY: DB	CKD BY: DB	C	100,042	D
APP BY: DB	DATE 7-2-63	SIZE		REV

ISSUE	REV.
B	CHANGES APPLY TO UNITS SERIAL # 26 & UP. B1, CHANGED CONNECTION ON F3-2 FROM T1 & T3 (FRONT PANEL) TO SW2-1 (FRONT PANEL) B2, CHANGED CONNECTION ON J1-10 FROM SW2-1 (FRONT PANEL) TO F3-1 (FRONT PANEL) B3, CHANGED CONNECTION ON J1-31 FROM F3-1 TO T1 & T3 (FRONT PANEL)
C	CHANGES APPLY TO UNITS SERIAL # 30 & FOLLOWING C1, ELIMINATE FUSE F2 - TERMINAL J7-14 WIRED DIRECTLY TO J1-30 C2, FUSE F3 REMOVED FROM REAR PANEL AND RELOCATED TO FRONT PANEL (C100,042)
D	CHANGE CAP. C-1 FROM 64uF TO 200uF START SER. 28
F	CHANGES AS SERIAL NO. 32 REV. P.N. 2 ON ALL CONNECTORS CASE GRD CONNECTION RUNS DIRECTLY TO CHASSIS SHIELD GRD, ISOLATED FROM CASE GLL BB 12/17/64
G	J1-28, ADDED LEAD TO T6 & T8 APPLIES TO SER # 42 BB 7-2-65 J1-10, ADDED LEAD TO J3-16 J3-6 WAS CASE GRD J3-18 CASE GRD ADDED APPLIES TO SER # 37 BB 7-2-65

APPLICABLE ONLY TO DWG. ISSUES A & B

115V GRD

J1-30 — F2 (1A) — J7-14

J1-10 — F3 (1A) — TB1 SW2-1 — TERM. FRONT PANEL

B+ DISTRIBUTION +22.5 V

TB4: J1-1, J8-1, J9-1, J2-1, J3-1, J4-1, J5-1, J7-17

J1 IMPEDOMETER ADMITTOMETER PLUG-IN

+22.5VDC — TB4-1
CASE GRD — J9-6
OSC INPUT 3VAC — TB2, T2
.03VAC (HI Z) OUTPUT & GRD METER RETN — J2-7, J7-7
3VAC REF SIGNAL — TB1, J3-11
GRD PWR SUPPLY REG RETN — J6-5
GRD PWR E.F. RETN — J9-5
GRD 90° CIRCUIT RETN — J8-5
GRD Z-Y AMP RETN — J2-5
SQUARING AMPL RETN — J3-5 — J3-16
SW2A1, SW2A5, SW2B5 — *SW1-B4, J8-3, *SW1-A4
TB1
APPROX 9V DC:
IN-PHASE RESOLVER: DIFF AMPL*1 OUTPUT — J5-10; DIFF AMPL*2 OUTPUT — J5-12; E.F. INPUT — J5-14
QUADRATURE RESOLVER: DIFF AMPL*1 — J4-10; DIFF AMPL*2 — J4-12; E.F. INPUT — J4-14
GRD IN-PHASE RESOLVER RETN — J5-5
GRD QUADRATURE RESOLVER RETN — J4-5
GRD +15V 60CPS POWER GRD — J7-14
GRD EXT OSC OR AMPL RETN — J7-15
INTERNALLY CONNECTED — T1 & T2 — T6 & T8 IN FRONT PANEL

TB2
TB1
CIRCUIT GRD

NOTE:
1. FOR FRONT PANEL SEE DWG. C 100,042.
2. INDICATES DIRECT WIRING TO FRONT PANEL.

J8 90° PHASE SHIFT NETWORK

+22.5VDC — TB4
CASE GRD — TB3
Q4 INPUT — J1-19
APPROX 40MVAC OUTPUT — J3-7
+22.5VDC RETN GRD — J1-14

FREQ. SEL.:
LOW — *SW1-B1
MID — *SW1-B2
HIGH — *SW1-B3
LOW — *SW1-A1
MID — *SW1-A2
HIGH — *SW1-A3
DIRECT WIRING TO SW1 ON FRONT PANEL

SHIELD RETURN — TB3

J9 POWER EMITTER FOLLOWER

+22.5VDC — TB4
CASE GRD
3VAC OUTPUT TO C1 — C1-1
3VAC OUTPUT — C1-2, *SW2-2
3VAC INPUT — J1-3
+22.5VDC GRD — J1-13

C1: 200 uF — J9-3 (3VAC), J9-4 (3VAC)

J2 Z-Y AMPLIFIER & LIMIT RELAY

+22.5V DC — TB4
CASE GRD
FIL. SW. — *SW5-3 (A)
FIL. SW. — *SW5-2 (A)
(1) 0V, W/CAL-O (2) 0.05V, W/CAL F.S. (INPUT Z AMPL) (FIL. SW.) — J1-16
-2VDC — J6-9
+22.5VDC RETN — J1-15
Q4 EMITTER — REL 1-A2
0V, W/CAL O; .8VAC, V/CAL F.S. — Z AMPL OUTPUT — REL 1-A3
J4-8, J5-8
DC LIMIT CONTROL — R5-1
APPROX 1VDC RELAY EXCIT — REL 1-4
DC LIMIT CONTROL — R5-2

J3 SQUARING AMPLIFIER

+22.5 DC — TB4
CASE GRD
40MV A.C. FIL. SW. — *SW5-3 (B)
FIL. SW. — *SW5-2 (B)
+22.5VDC RETN — J1-16
40MVAC INPUT FROM 90° PHASE SHIFT NETWORK — J8-4
3VAC FIL. SW. — *SW5-3 (C)
3VAC FIL. SW. — *SW5-2 (C)
TB8
SQ. WAVE APPROX 1V PK-PK — J4-6
3VAC FIL. SW. REF — J1-9
+22.5V DC RETURN — J1-16
SQ WAVE APPROX 1V PK-PK — J5-6
CASE GRD

TB2
TB8
CIRCUIT GRD

RELAY*1

A — TB1, J2-9, J2-11
B — J7-11, J7-9
C — J7-25, J7-21
D — J7-2, J7-3, J2-1, J2-17

R5: J2-16, J2-18

J6 D.C. REGULATOR

+22.5VDC — J 7-18
CASE GRD
+22.5VDC RETN GRD — J1-12
-6.2VDC — J5-16, J4-16
-2.0VDC — J2-6
-17VDC RETN GRD — TB7-2
+27VDC RETN GRD — TB7-4
-17VDC — TB6-2
+27VDC — TB6-4

TB5

J7-1 — TIE TO PRIMARY OF T1 & T2 — J7-13

J6-18 +27VDC
J6-16 -17VDC

TB6 TB7 RECTIFIER FILTER

J4 QUADRATURE RESOLVER

+22.5VDC — TB4
CASE GRD
J1-29, J7-12
+22.5VDC RETN GRD — SW5-3D
FIL. SW. GRD — SW5-2D
FIL. SW. GRD — SW5-2E
FIL. SW. GRD — SW5-2F
INPUT SQ. WAVE PK-PK (0.8VAC, W/CAL FS; 0V W/CAL O) — J5-13, J2-11
APPROX 9VDC — J1-25
APPROX 9VDC INPUT FIL. — J1-26
W/CAL O; W/CAL FS
APPROX 9VDC — J1-27
-6VDC SUPPLY — J6-7
+1VDC ZERO ADJ POT HI — J7-10
DC (0V, W/CAL O; 0.8V, W/CAL FS) — J7-11

J5 IN-PHASE RESOLVER

+22.5VDC — TB4
CASE GRD
J1-28, J7-24
+22.5VDC RETN GRD — *SW5-3G
FIL. SW. GRD — *SW5-2G
FIL. SW. GRD — *SW5-2H
FIL. SW. GRD — *SW5-2I
INPUT SQ. WAVE PK-PK (0.8VAC, W/CAL FS; 0V W/CAL O) — J3-17, J2-11
APPROX 9VDC — J1-22
APPROX 9VDC INPUT FIL. — J1-23
W/CAL O; W/CAL FS
APPROX 9VDC — J1-24
-6VDC SUPPLY — J6-7
+1VDC ZERO ADJ POT HI — J7-22
0V W/CAL O; -0.8V, W/CAL FS — J7-23

J7 FRONT PANEL INTERFACE CONNECTOR

115V HI — TB5
115V LO — TB5
LIMIT LAMP — REL
115V LO — REL
SHIELD RETN — TB2
METER RETN — J1-5
3VAC RETN — J7-7
QUADRATURE RESOL RETN — REL
(X) ZERO ADJ POT — J4-1
QUADRATURE RESOL OUTPUT — J4-2
QUADRATURE RESOL RETN — REL
115VDC GRD — J4-5, J1-3
IN-PHASE RESOL RETN — TB4
(R) ZERO ADJ POT — J6-1
IN-PHASE RESOL RETN — REL
IN-PHASE RESOL OUTPUT — J5-1, J5-5, J5-11
REL

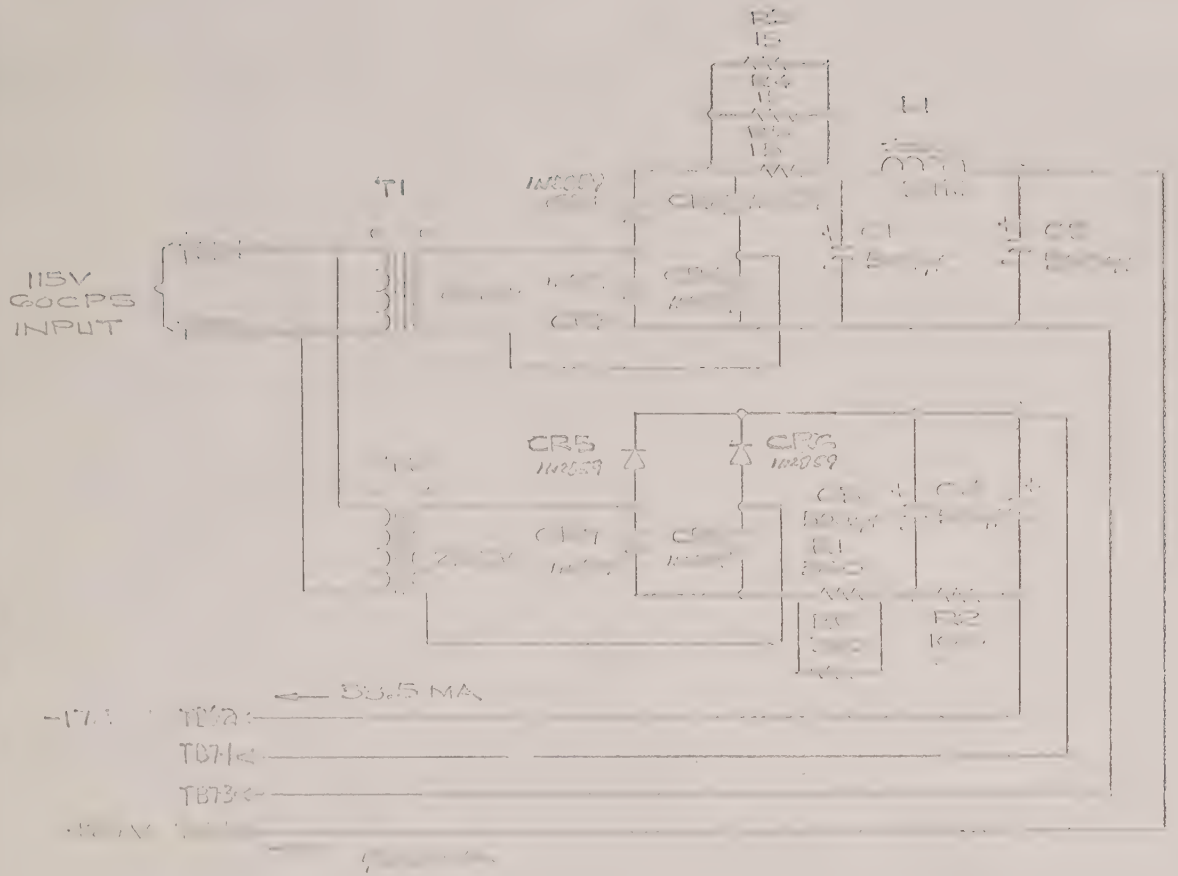
REVISIONS PER VAU.'S	
	DATE

DRANETZ ENGINEERING LABS INC.
11 WASHINGTON AVENUE, PLAINFIELD N.J.

TITLE: SCHEMATIC WIRING DIAGRAM REAR PANEL MOD. 100

DWG BY: BB CHK'D BY: BB
APP BY: BB DATE 7/14/13 SIZE D 100,043

REV	DESCRIPTION



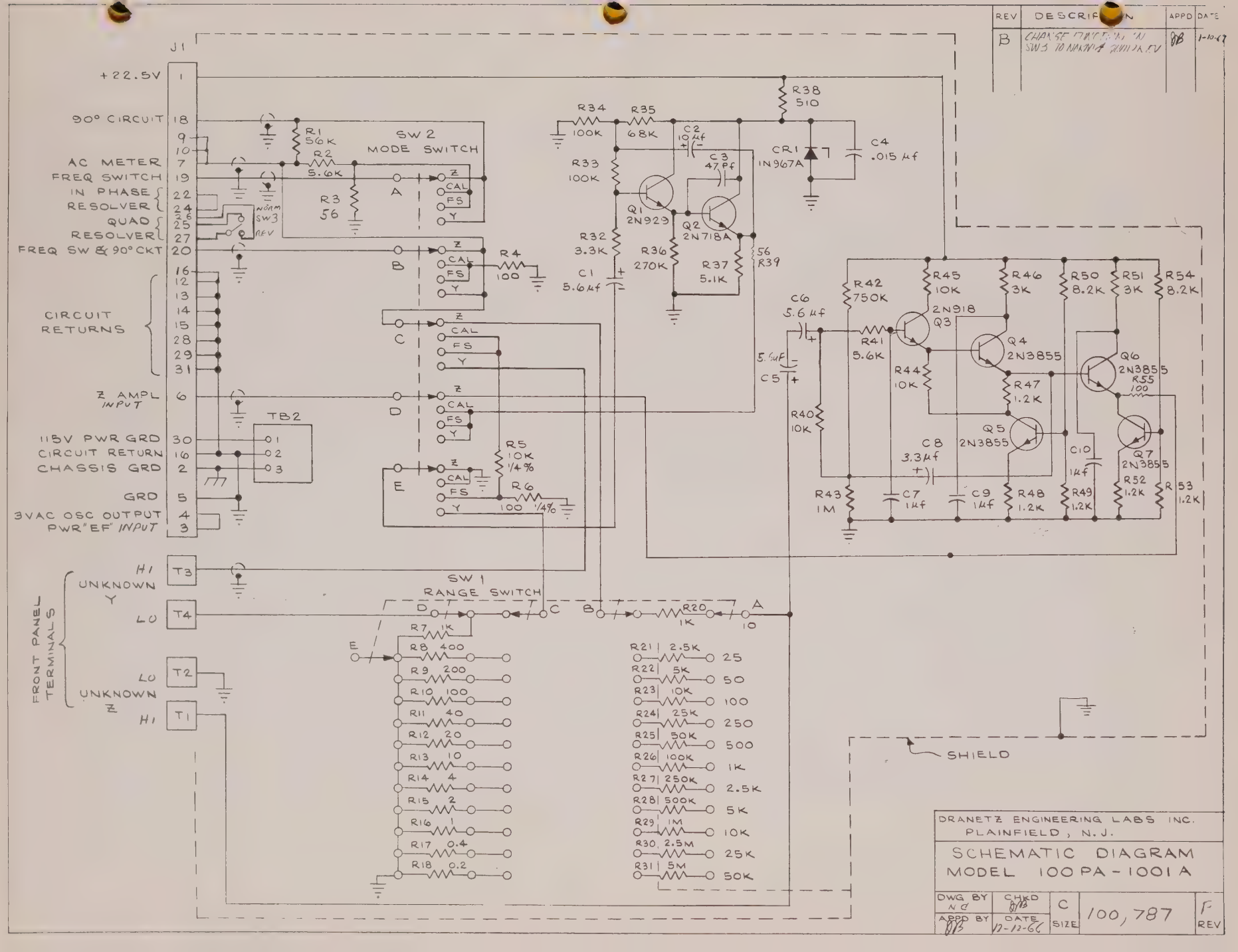
NOTES
1. ALL [illegible] TOLERANCES ARE 5% 1/2 WATT
2. FOR [illegible] ASSY DWG. SEE D100035

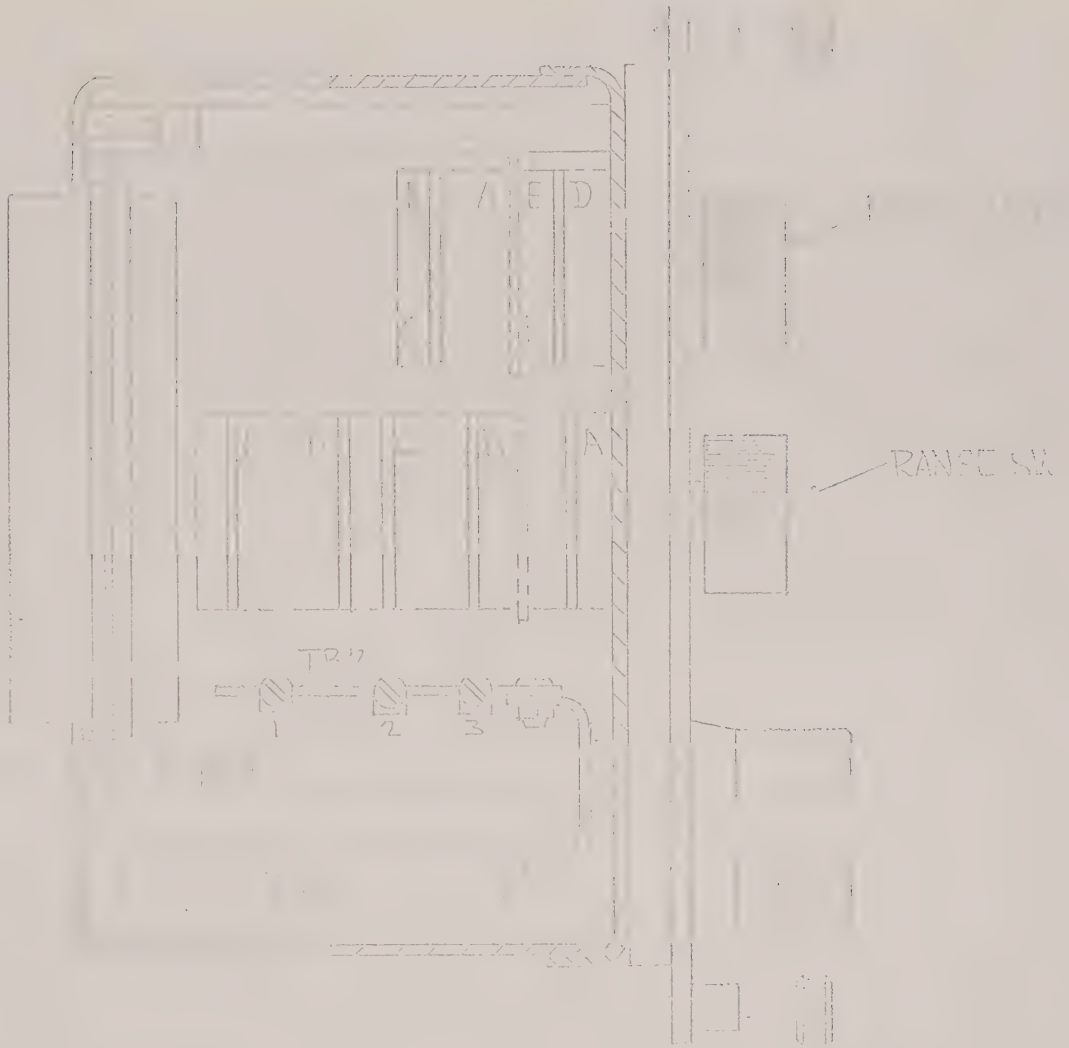
DUPLICATED FOR VAULT

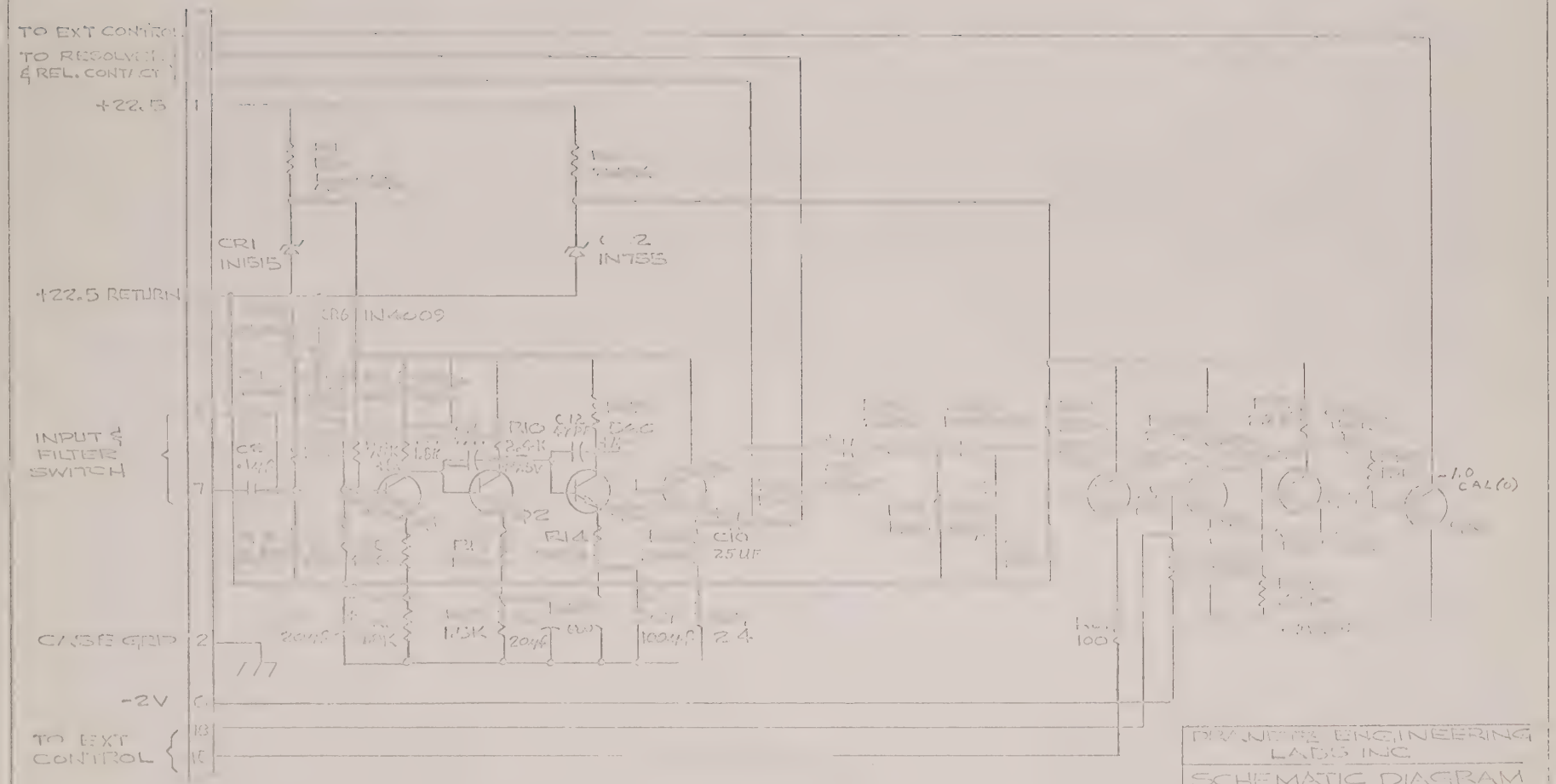
ISSUE	DATE
A	[illegible]

PROJECT [illegible]
PLANT [illegible]

SCHEMATIC DIAG[illegible]
POWER SU[illegible]
[illegible]


REV
DESCRIPTION
APPD
DATE
B
CHANGE TRANSISTORS IN SW3 TO NAKAMA 2N1132
DB
1-10-67
J1
+22.5V
90° CIRCUIT
AC METER
FREQ SWITCH
IN PHASE RESOLVER
QUAD RESOLVER
FREQ SW & 90° CKT
CIRCUIT RETURNS
Z AMPL INPUT
115V PWR GRD
CIRCUIT RETURN
CHASSIS GRD
GRD
3VAC OSC OUTPUT
PWR "EF" INPUT
R1 56K
R2 5.6K
R3 56
SW2 MODE SWITCH
NORM
REV
SW3
Z
CAL
FS
Y
A
B
C
D
E
R4 100
R5 10K 1/4%
R6 100 1/4%
TB2
R34 100K
R35 68K
C2 10µf
C3 47pf
R33 100K
Q1 2N929
Q2 2N718A
R32 3.3K
R36 270K
R37 5.1K
56 R39
C1 5.6µf
R38 510
CR1 IN967A
C4 .015µf
C6 5.6µf
5.6µF
C5
R42 750K
R41 5.6K
R44 10K
R40 10K
R45 10K
2N918 Q3
Q4 2N3855
R47 1.2K
Q5 2N3855
C8 3.3µf
R43 1M
C7 1µf
C9 1µf
R48 1.2K
R46 3K
R50 8.2K
R51 3K
R54 8.2K
Q6 2N3855
R55 100
C10 1µf
Q7 2N3855
R52 1.2K
R49 1.2K
R53 1.2K
SW1 RANGE SWITCH
R20 1K
10
R7 1K
R8 400
R9 200
R10 100
R11 40
R12 20
R13 10
R14 4
R15 2
R16 1
R17 0.4
R18 0.2
R21 2.5K 25
R22 5K 50
R23 10K 100
R24 25K 250
R25 50K 500
R26 100K 1K
R27 250K 2.5K
R28 500K 5K
R29 1M 10K
R30 2.5M 25K
R31 5M 50K
FRONT PANEL TERMINALS
HI UNKNOWN Y
LO
LO UNKNOWN Z
HI
T3
T4
T2
T1
SHIELD
DRANETZ ENGINEERING LABS INC.
PLAINFIELD, N.J.
SCHEMATIC DIAGRAM
MODEL 100PA-1001A
DWG BY NC
CHKD DB
APPD BY DB
DATE 12-12-66
C
SIZE
100,787
F
REV


A
E
D
RANGE SW.
TRY
1
2
3



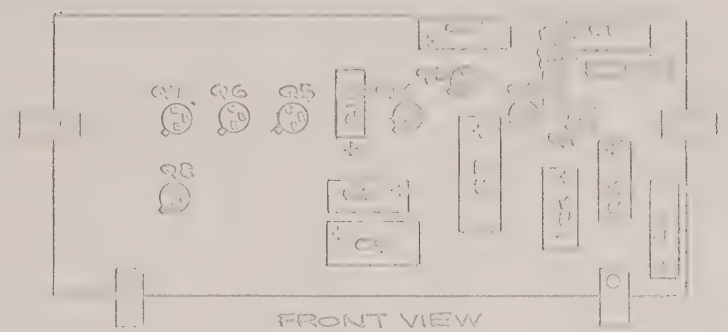
NOTE:
1. FOR ASSEMBLY SEE B100,040
2. ALL RESISTORS ¼ WATT 5%
UNLESS OTHERWISE INDICATED
STD SAMPLE 2N2222A

REV	DESCRIPTION

DYNAMICS ENGINEERING LABS INC

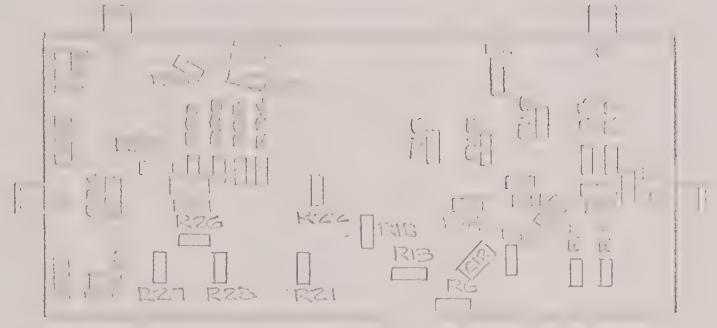
SCHEMATIC DIAGRAM
½-AMP 5 LIMIT RELAY

REV	DESCRIPTION



FRONT VIEW

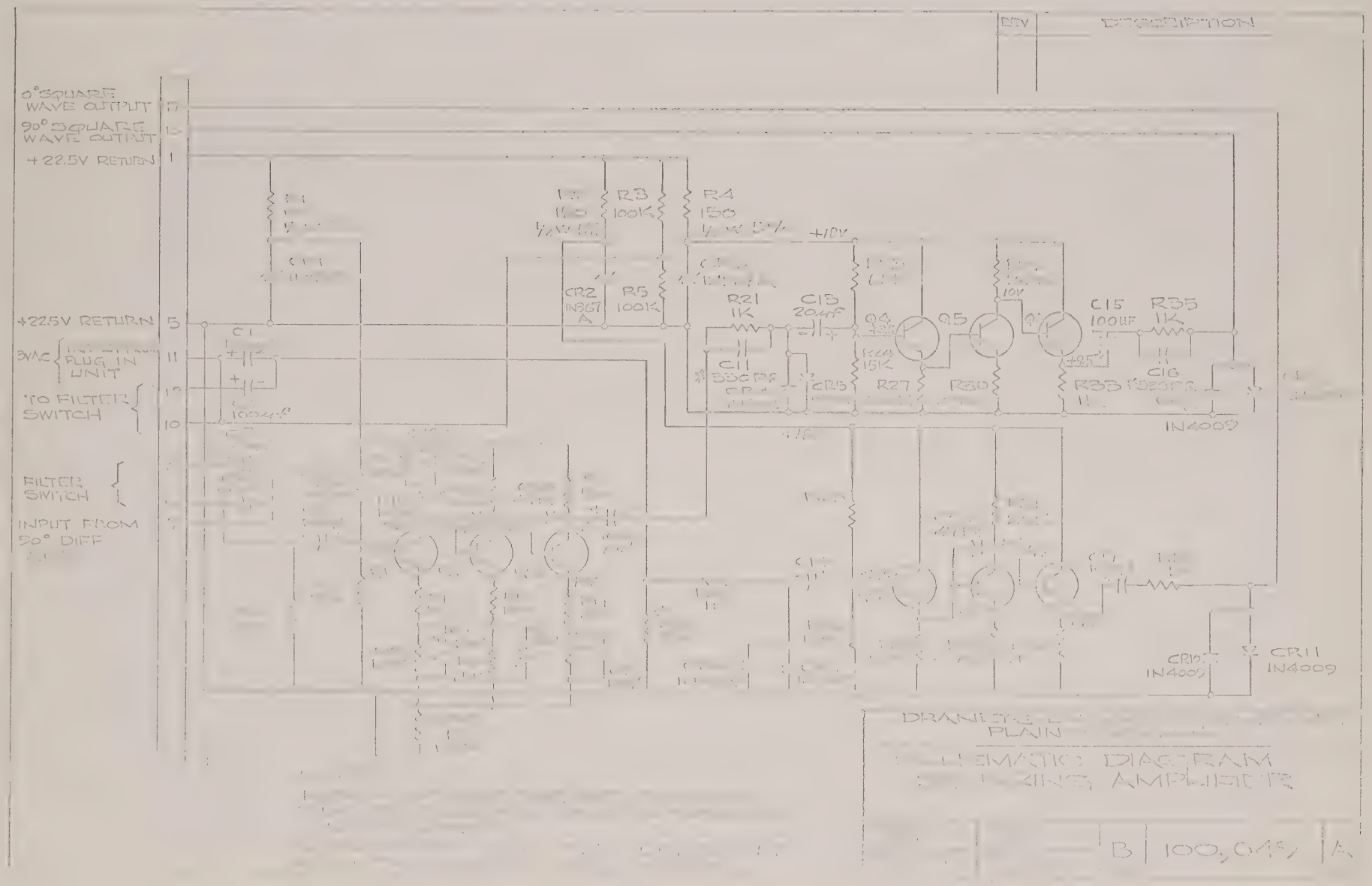
NOTE:
SCHEMATIC : 6100,071



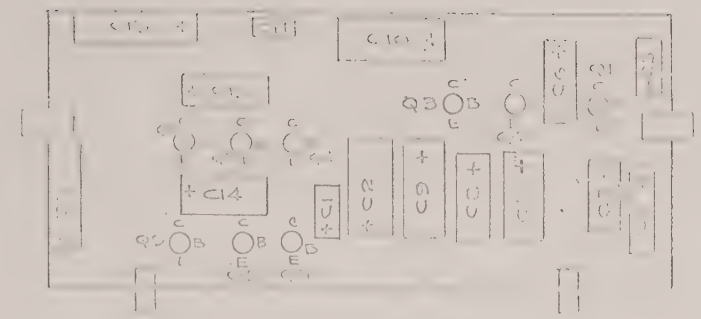
REAR VIEW

DRANETZ ENGINEERING LABS INC.

LAYOUT
Z-Y AMPLIFIER


REV
DESCRIPTION
0° SQUARE WAVE OUTPUT
90° SQUARE WAVE OUTPUT
+22.5V RETURN
+22.5V RETURN
3VAC
TO FILTER SWITCH
FILTER SWITCH
INPUT FROM 90° DIFF
R3 100K
R4 150
+10V
CR2 IN967 A
R5 100K
R21 1K
C13 20uF
C11 330PF
CR9
R27
Q4
Q5
C15 100UF
R35 1K
C16
R33
IN4009
CR10 IN4009
CR11 IN4009
DRAWN
PLAIN
B
100,045
A

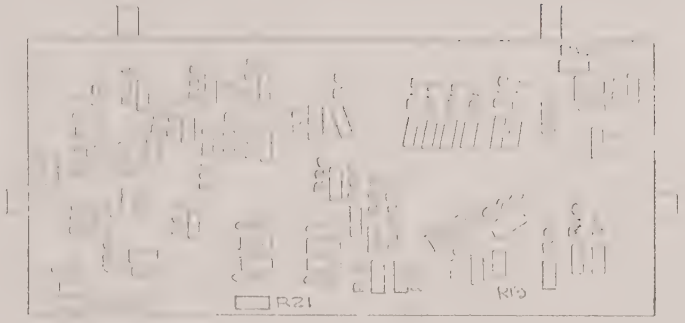
	DESCRIPTION



FRONT VIEW

NOTE:

SCHEMATIC: BIC⊕,049



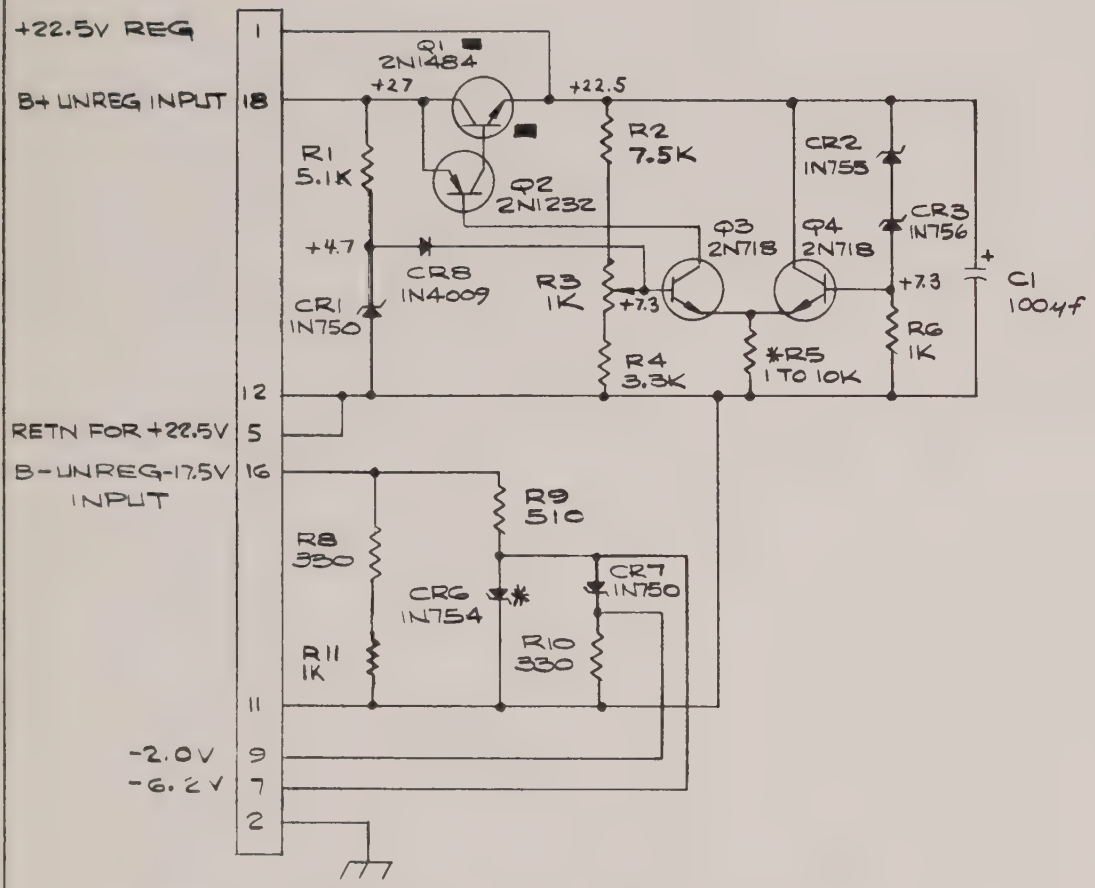
REAR VIEW

DRANETZ ENGINEERING LABS INC
PLAINFIELD N. J.

LAYOUT
SQUARING AMPLIF

		B	⊕,134	A

REV	DESCRIPTION

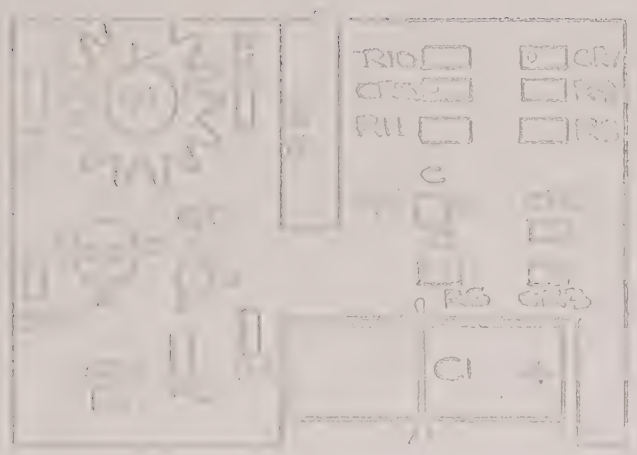


NOTES:
1. FOR ASSEMBLY DWG SEE B100,038.
2. RESISTORS ARE 1/4 WATT 5%
3. * INDICATES SELECTED COMPONENT
4. ■ INDICATES HEATSINK REQD

DRANETZ ENGINEERING LABS INC.
PLAINFIELD N.J.

SCHEMATIC DIAGRAM REGULATOR FOR POWER SUPPLY

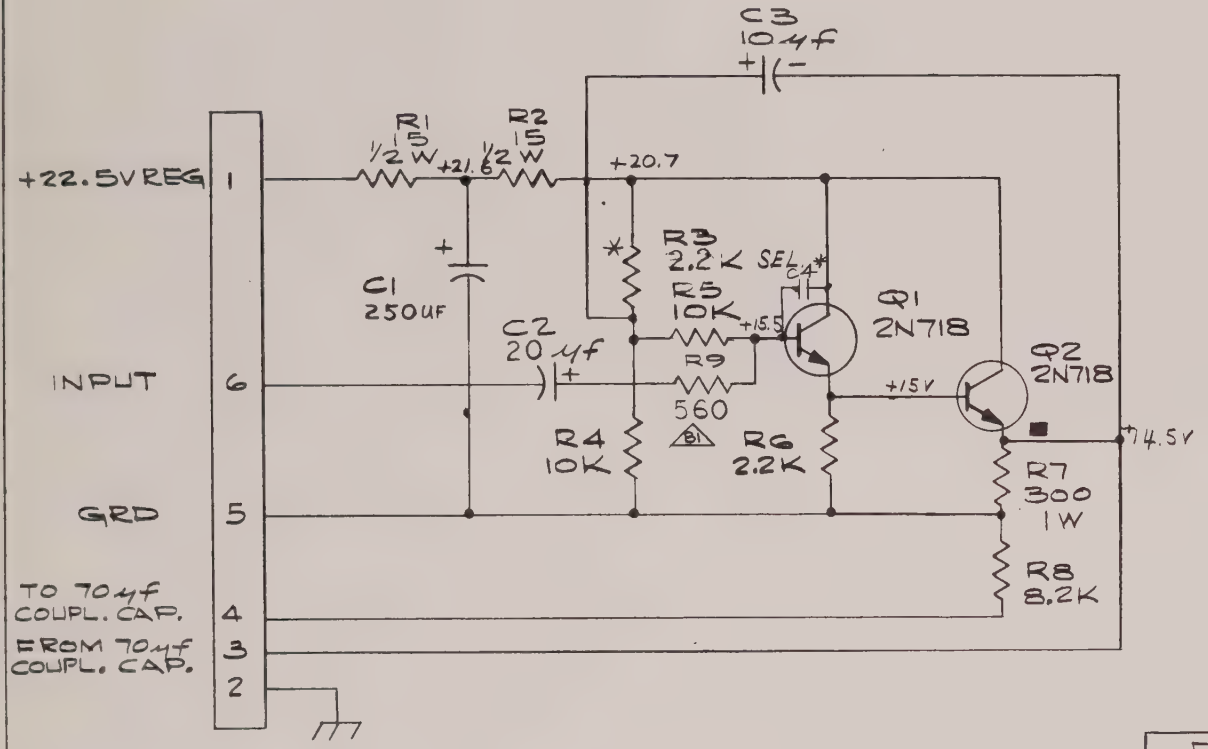
DWG BY	CKD BY			
APPD BY	DATE 9/19/63	B SIZE	100,051	A ISSUE



NOTE :
SCHEMATIC : B100_031

LAYOUT

LET.	DESCRIPTION
B	ALL UNITS SERIAL #19 & FOLLOWING ADD R9 NOTE: THIS CHANGE SHOULD BE MADE ON ALL PRIOR UNITS



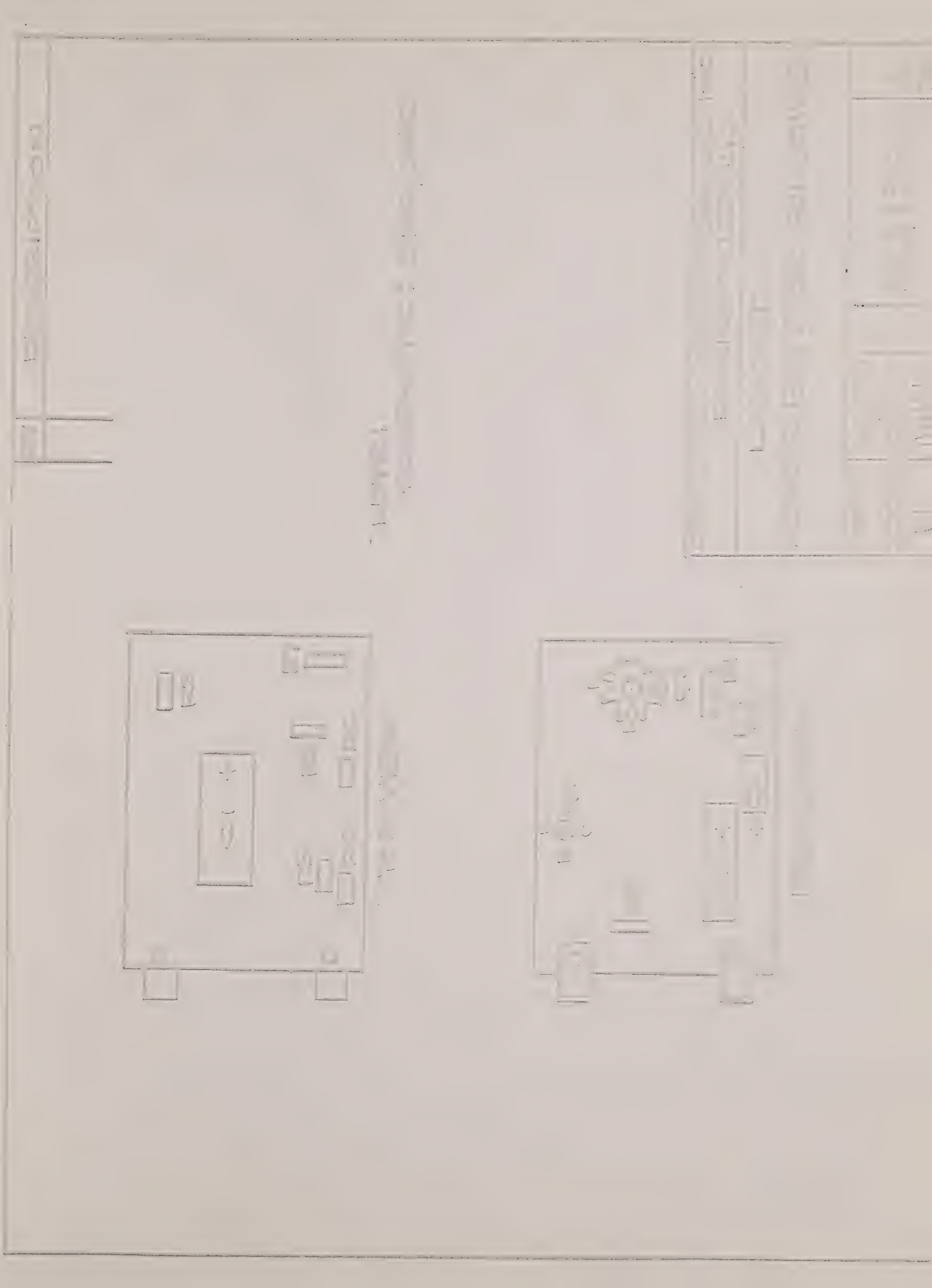
NOTES:
1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE 1/4 WATT ±5%.
2. FOR ASSEMBLY DWG SEE B100,036
3. ■ INDICATES HEAT SINK REQD FOR COMPONENT.

DUPLICATED FOR VAULT	
ISSUE	DATE
B	1-6-64

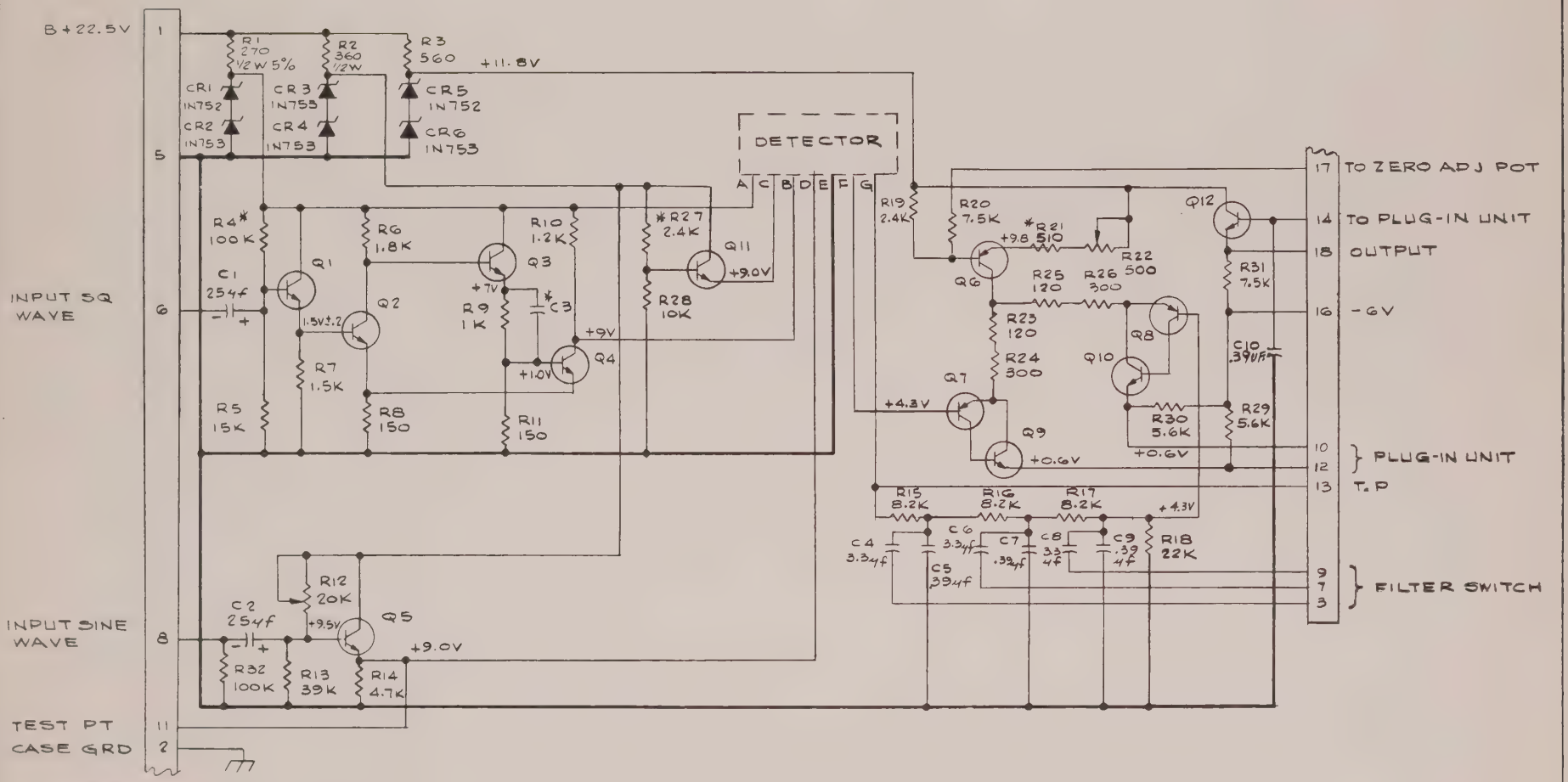
DRANETZ ENGINEERING LABS, INC.
PLAINFIELD N.J.

SCHEMATIC DIAGRAM OF POWER EMITTER FOLLOWER

DWG BY	CHD BY	SIZE	DWG NO.	ISSUE
APPD BY	DATE 9/19/63	B	100,046	B



REV	DESCRIPTION	APPD
B	R22 WAS 200Ω, 1/2 W ADDED 510Ω EFFECTIVE SERIAL NO.	



NOTES:
1. FOR ASSEMBLY DWG SEE B100,609
2. ALL RESISTORS ARE 1/4 WATT 5% UNLESS OTHERWISE SPECIFIED
3. * INDICATES SELECTED COMPONENT
4. UNLESS OTHERWISE SPECIFIED ALL TRANSISTORS ARE 2N2221 OR 2N3855A
5. ALL PNP TRANSISTORS ARE 2N3638 OR 2N3251 (Q6, Q7, Q8)

DRANETZ ENG LABS INC
PLAINFIELD N.J.

SCHEMATIC DIAGRAM
RESOLVER CIRCUIT

DWN BY	CHK'D			
R.S. 4-8-66	4/8/66			
APP'D	DATE	C SIZE	100,607	B REV

MANUAL CHANGE

Delete and substitute the following

1-15 INSTALLATION

a. Non-rack installation
The instrument is shipped ready for operation. Special instructions are given below.

(1) Connect instrument to 115 volt 60 cycle power.

(2) Grounding
The instrument must be grounded to the ground terminal (located on the front of the Impedometer-Admittometer plug-in) or through the power cable, but not to both places.

Note 1: Main frame units having serial numbers through 21 have a fuse (F2) in the power line ground circuit. Higher serial numbers units do not.

Note 2: Impedometer-Admittometer plug-in (model 160-P4-1001) having serial numbers up to #21 have chassis and circuit ground permanently connected. Shorting wire serial #22, power line ground, circuit ground, and chassis ground appear on the separate screw terminals (see section 3, 160-P4-1001) inside the plug-in (front panel ground is DIRECTLY ground). Units #22 and up to be connected as another electrical ground, to the equipment that the instrument operating (i.e. chassis ground and circuit ground terminals be connected).

Section I

Mounting of a 19" rack is accomplished by the addition of an auxiliary 1/8" thick plate between the front panel and carrying case of the instrument. This auxiliary plate also has the cut-outs for storing plug-ins.

On orders for rack mounted units, the auxiliary plate is generally shipped unmounted to provide better shipping protection and allow the instrument to be used portably if a rack is not available. The procedure for installing the plate is as follows.

(a) Place the DM-1000 on a bench top, with cover facing up and handle facing to the rear.

(b) Remove all 12 binding head screws (#4) located around the edge of the front panel set the instrument up so that the handle faces up, retract the instrument from the carrying case and set this aside. Turn the empty case back to its original position, handle away.

(c) Remove the bag of four screws attached to the rack mounting plate, and with the slot mounting brackets facing downward, place the plate on the open end of the box, centering the large cut out over the opening, with the covered holes for adapters to your right.

(d) Pick up the DM-1000 assembly and place it in the cut out of the rack mounting plate, making sure that engraving is readable, then box handle is away, the adapter cut outs are on right.

(e) Mount DM-1000 firmly to rack mounting plate, using 4 of the 12 original screws (do not install in corners).

Then using the 1 longer screw, lockwasher, and nut mounting, attach the front panel to the box by going through the four corner holes.

Note 1: Do NOT destroy the box cover. This can be used whenever it is desired that the instrument be used portable.

Note 2: The front panel should not be attached until the unit is rack mounted.

(2) Grounding

To avoid circulating ground, it is recommended that all three grounds be left disconnected in the front panel plug-in if the rack system is grounded. In this manner the circuit ground can be connected separately to the main ground.

Note: The chassis ground terminal is used internally as a common for all circuits (except those which are driven--for example, in the plug-in). Thus if the main rack is NOT ground, this may result in a good deal of pickup.

CAUTION

THE SWEEP OF OSCILLOSCOPES MAY BE VERY ERRONEOUS, PARTICULARLY IN CERTAIN MULTI-BEAM SYSTEMS, SUCH AS INVOLVED IN ELECTROCARDIOGRAPHIC EQUIPMENT. THIS IS PARTICULARLY TRUE WHEN VIEWING LOW LEVEL WAVEFORMS. THE BEST RULE TO FOLLOW IS TO MAINTAIN A SMALL KNOWN SIGNAL.

Functions of controls, in brief, are described.
In Model 1X-1 units having serial numbers up to and including #29, the [illegible] on the rear of the panel. On units having serial #30 or above, this is located on the front panel [illegible] when the [illegible]

ORDER 100-Pa-1001 dated
March 31, 21 or less are described
Units having serial numbers of
[illegible]

1. Paragraph 3-7 Impedance Measurement
The constant current arrangement shown in Figure 3-9 is used for ALL impedance ranges. When the constant current resistor (R19) is trimmed the full-scale full scale value of impedance for ALL ranges.

2. On all units, circuit ground, chassis ground and power line ground are brought individually into the Impedometer-Admittometer plug-in for interconnection. In 100-Pa-1001 units with serial #21 or lower, these grounds are permanently connected and brought to the GROUND terminal on the front panel. On units of higher serial numbers, the grounds are brought into separate screw type terminals mounted on the housing next to the front panel GROUND terminal using chassis ground. The operator has the option of ground interconnection to suit his need best (see earlier section of this amendment).

PLUG-IN IMPEDANCE ADMITTANCE

MODEL 100-PA-1001A

All units of this model plug-in incorporates the ground, and constant current source features described for the 100 PA-1001 for serial # 22 and thereafter.

In addition, this plug-in incorporates a switch by which the output phase of the quadrature channel can be reversed. This is particularly useful when plotting the logarithm of a negative reactance, since many logarithmic amplifiers are not capable of handling negative d.c. voltages. It should be noted that the switch reverses the polarity of the quadrature channel both at the output terminals and across the panel meter. Thus with the switch in the reverse position, the meter will read positively when the MODE switch is in the CAPS position.

AMENDMENT B TO INSTRUCTION MANUAL

CIAM MODEL 100B

Add the following to SECTION II - OPERATION

2-8 Effects of distortion and noise in oscillator signal.

Because of the frequency sensitivity of internal networks and of the unknown under test, it is important that the input signal be a clean sine wave, free of harmonics and out of band noise. Generally maintaining total harmonic distortion below 0.5% will be satisfactory. Below are some problems which have been encountered along with means for their avoidance.

(a) Noise

(1) The problem

The presence of noise (even out of band) in the 3 volt rms input, may cause one of several problems. First, low frequency noise may not be completely filtered out in the resolvers, resulting in a non-periodic change in panel meter readings and d.c. outputs. In addition, low or high frequency noise may upset the operation of the 90° phase shift network and result in erroneous readings, particularly in the quadrature channel. In particular, the quadrature channel may read properly in the CAL FS position, but have a considerable error when a reactive unknown is connected.

(2) Sources of noise

(a) Certain resistively tuned oscillators generate noise when the tuning potentiometer is moved.
(b) Any oscillator in poor condition.
(c) Beat frequency oscillators may have the high frequency fixed frequency signal riding on the output. This can be checked by an oscilloscope when the problem arises. For this reason, capacitively tuned Wien bridge oscillators are preferred.
(d) Frequency counters are capable of generating sharp pulses into the circuits being measured.

(b) Waveform distortion

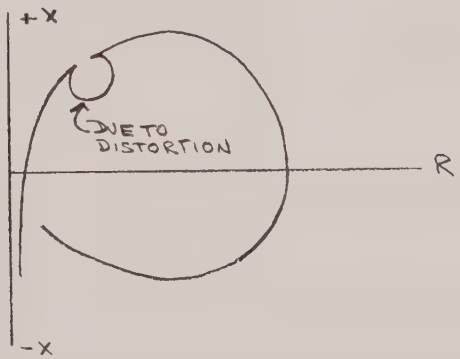
(1) The problem

The synchronous detectors used in this instrument are sensitive to odd harmonics (but not even harmonics) of the reference signal, producing a d.c. output proportional to the following:

Frequency		D.C. Output
Fundamental	V_1	KV_1
3rd harmonic	V_3	$K\frac{V_3}{3}$
5th harmonic	V_5	$K\frac{V_5}{5}$
7th harmonic	V_7	$K\frac{V_7}{7}$

(2) Sources of distortion

(a) The signal source may have distortion either directly, or when certain frequency counters or vacuum voltmeters are connected. Even a small percent of harmonic distortion in the 3 volt signal may be amplified when the unknown has a substantial Q and is resonant at a frequency corresponding to the harmonic components. An impedance plot which has been observed on a parallel tuned circuit under such conditions is given below.



(b) The presence of ripple on a transducer due to d.c. bias may also cause an artifact resonant loop when the test frequency is approximately equal to the ripple frequency or harmonic of the ripple frequency.

Add the following to SECTION IV - MAINTENANCE

4-8 IMPROPER RELAY CLOSURE

Proper closure of the contacts of the LIMIT INDICATOR relay (RL#1) may be impaired by dirt collecting between contacts.

a. Symptoms.

Condition #1 - Inability to make output meters move off zero during operation or when MODE switch is in CAL FS position. Likewise, no d.c. output is attainable. This may take place even though the LIMIT INDICATOR does not light.

Condition #2 - In OPERATION (during overload) meters and outputs indicate zero, but overload lamp does not light. In CAL FS, meters and output read properly.

Condition #3 - During OPERATION, overload, indicator lights, but meters and outputs do not read zero.

b. Correction.

(1) Remove the instrument from its carrying case by removing the 12 screws around the edge of the front panel.

(2) Slip a dry file card or piece of paper between each of the sets of contacts, work back and forth lightly to push out dirt.

APPENDIX C

OPERATING INSTRUCTIONS FOR

IMPEDOMETER-ADMITTOMETER PLUG-IN

Model 100-PA-1001A

The Impedometer-Admittometer Plug-in Model 100-PA-1001A is an updated version of the Model 100-PA-1001. The functions of the units are similar except that the Model 100-PA-1001A has additional and improved features such as:

(1) Normal - Quad. Rev. Switch
(2) Sig. Mon. Test Points
(3) Separate unknown Z or Y terminals. The following Table describes the function of controls for the 100-PA-1001A Plug-in. The location of these controls are shown in Figure C-1. Drawing No. 100,848 is an internal view showing position of ground terminals and location of switch decks. Drawing No. 100,787 is a schematic diagram of this plug-in unit.

Index No.	Control, Indicator or terminal	Function
1	CAL 4-position switch Z-O-FS-Y	FS and O - Adjustment of zero and full Precalibration holds for any ampl range of impedance or admittance. Z - Impedance.
2	Ohm or Micromho 12-position range switch 12 positions: 10 - 25 - 50 - 100 - 250 - 500 - 1K - 2.5K - 5K - 10K - 25K - 50K	Presets full-scale ranges for admittance and impedance. Impedance is indicated in series resistance or reactance. Admittance is indicated in parallel conductance and susceptance.
3	Unknown Z terminals Red - High side Black - GRD. side	Five way terminals for measuring impedance.
4	Unknown Y terminals Red - HIGH Black - LOW	Five way terminals for measuring admittance. Note that for admittance measurement, both terminals are ungrounded.

...eter Plug-In
...A Controls

Index No.	Control, Indicator or Terminal	Function
5	SIG. MON. Test Point	Provides a monitor output signal of 30 millivolts for trouble shooting, observing the waveform of voltage across the unknown when measuring Z, and observing the voltage (representing current through the unknown) for measuring Y. The SIG. MON. test point can be used as [illegible] when required in the same manner described in the basic handbook.
6	NORMAL-QUAD. REV. Toggleswitch	In normal position, the d-c output [illegible]g will provide a direct reading of the parameter being measured. In QUAD. REV. po[illegible] [illegible] recording instrument requires positive going voltages for all measurements.

SERVICE RECORD

Inc.

Loco. _____ Plug _____

Unit _____

Date _____ Mfr. _____

Owner _____

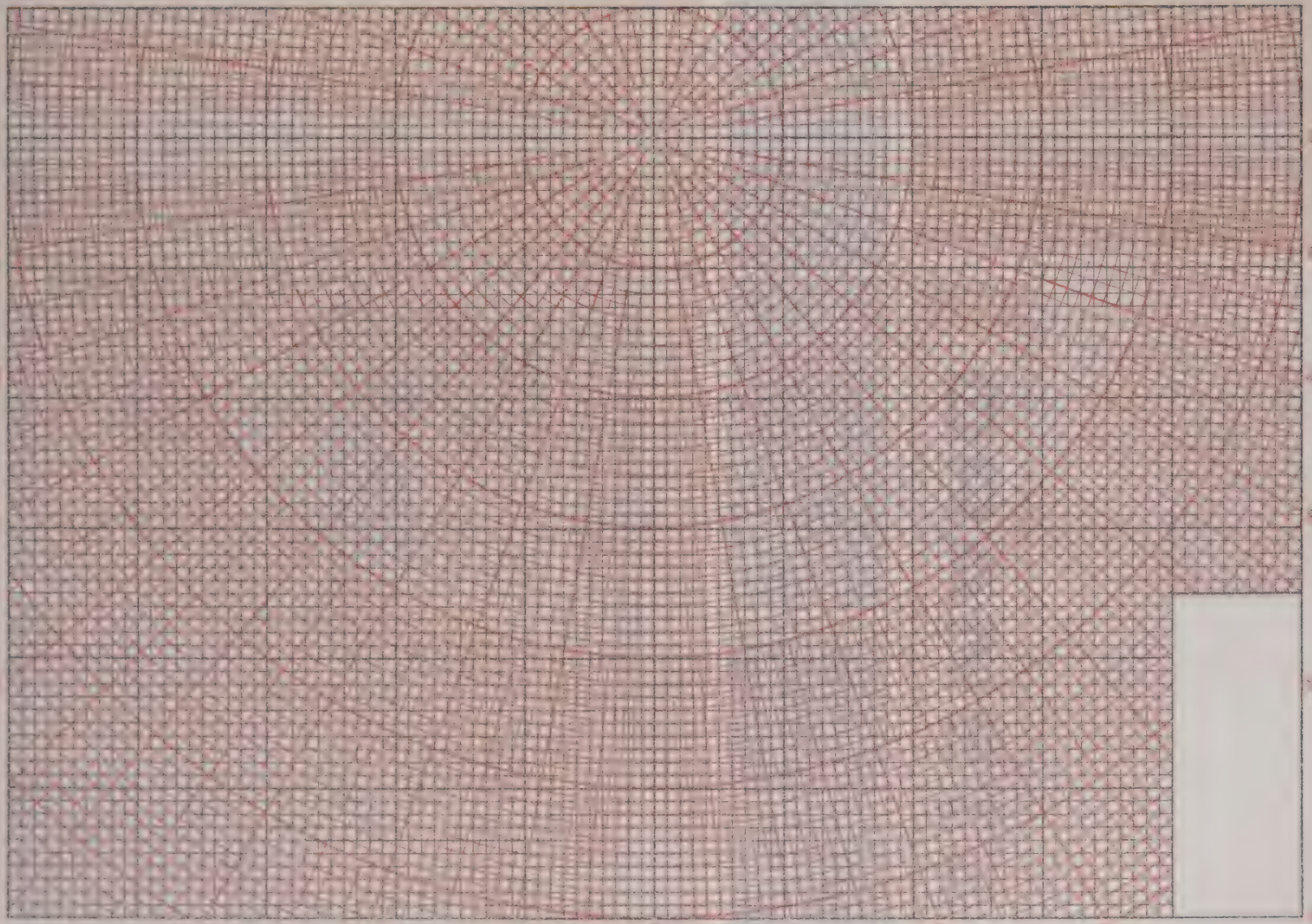
Name and address

Original P.O. _____

Date	Reason for Service	Service performed

SPECIAL POLAR GRAPH PAPER TYPE SPL-5
POLAR DISAPPEARS IN VERIFAX

DRANETZ ENGINEERING LABORATORIES, INC.
PLAINFIELD, N. J., U.S.A.
SPL-5 SERIES



DRAWN AT ENGINEERING LABORATORIES, INC.
PLAINFIELD, N. J., U.S.A.
SPI-2 SERIES

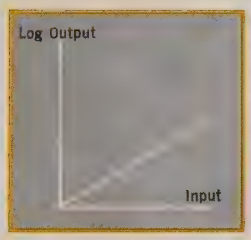
INCIDR DISAPPEARS IN THERMOFAX, SCM
OZALID, XEROX AND APECO REPRODUCERS

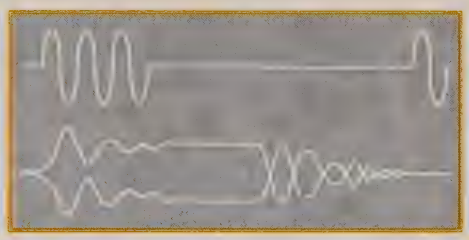
DRAFTZ ENGINEERING LABORATORIES, INC.
PLAINFIELD, N. J., U.S.A.
SPL-5 SERIES

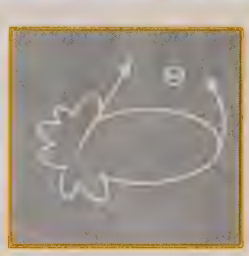
DRAFMETS ENGINEERING LABORATORIES, INC.
LAYNFIELD, H. I., U.S.A.
25F-2 SERIES

COPYRIGHT XEROX AND XEROX REPRODUCERS
BOYAR DISPLAYBOARD IN THERMOFAX SCM
NONREFLECTIVE MATTE FINISH PAPER TYPE 25F-2-BK

DRANETZ







PRECISION INSTRUMENTS FOR THE MEASUREMENT OF:

- IMPEDANCE
- PHASE ANGLE
- ADMITTANCE
- CURRENT
- TRANSFER FUNCTION
- QUALITY Q FACTOR
- REAL & IMAGINARY POWER

COORDINATE CONVERTERS • COMPUTING MODULES • AUTOMATED TEST SYSTEMS

INTRODUCTION

This catalog will introduce you to the Dranetz line of precision instruments. Known as a manufacturer of precision, quality and reliable standard instruments, Dranetz is also a leader in the field of automated test and training systems.

Dranetz Engineering Laboratories Inc. is comprised of a highly skilled team of engineers having many years of experience in the design and manufacture of precision instruments and systems. The company's engineering staff is continuously up-dating Dranetz instruments and systems, taking advantage of the latest developments in the electronics state-of-the-art to provide its customers with the best quality at the most economical price.

Each instrument utilizes the latest integrated circuits and solid-state components. Modular construction has been engineered into many instruments to provide added versatility and ease of maintenance.

To allow integration into computer controlled instrumentation systems, many instruments are provided with programmability or command options which also provide interfacing with data acquisition and logging systems. Digital readouts and BCD outputs are standard in many instruments or optional in others. Should your application not presently call for computer compatibility, you can specify a Dranetz instrument which can be manually operated with added provision for programmability.

Plug-in versatility in another Dranetz feature. Several instruments in this catalog are built around rugged and reliable main frames to which an assortment of plug-in can be added as requirements and demands dictate.

Some of the unique Dranetz circuits used in these instruments are also available in modular form and are found in the Modular Components section of this catalog.

In addition to its excellent line of standard instruments, Dranetz is heavily involved in the development and manufacture of automated test and training systems and devices. The company has extensive and unusual capability in the design and manufacture of oceanographic and ASW equipment, having provided systems for the Naval department for both ship-board and shore-based use.

Automated component and network test systems is another area in which Dranetz has developed considerable experience and expertise. Its extensive experience in analog and digital techniques allow Dranetz to provide its customers with systems for measuring a multitude of parameters while making the equipment compatible with computer systems. Page 11 provides a more extensive description of our systems capabilities.

Our highly technical engineering and sales force is readily available to assist you or supply you with additional information to enable you to meet your specific requirements.

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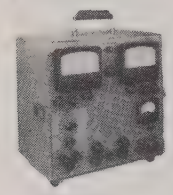
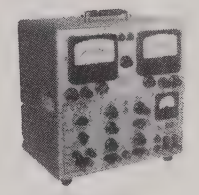
SERIES 100

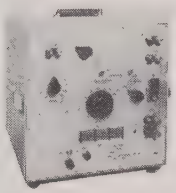
COMPLEX IMPEDANCE, ADMITTANCE AND TRANSFER FUNCTION METERS


MODEL 100B


MODEL 100C

PLUG-IN 100-PA-1013

PLUG-IN 100-PA-1009

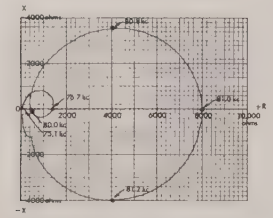

ADAPTER 100-PA-1011B

FEATURES:

- Direct Reading of Impedance, Admittance and Transfer Function
- Wide range of input levels
- Differential measurements for high accuracy
- Wide frequency range
- DC outputs for continuous plotting
- Plug-in versatility

APPLICATIONS:

- Electrical Components Testing
  Rapid testing of resistors, inductors, capacitors, crystals and transformers
  Non-linear analysis
- Materials Research
  Dielectric and magnetic properties
- Electro-acoustical Transducers
  Resonance frequencies and mechanical Q
  Coupling coefficient
- Active and Passive Networks
  Impedance and transfer function
- Mechanical and Acoustical Systems
- Impedance studies in Physiology



Complex Impedance plane plot of piezo-electric ceramic disk. (Plotted on X-Y recorder in 20 seconds.)

Series 100 Complex Impedance, Admittance and Transfer Function Instruments is comprised of a family of highly accurate main frames and plug-ins for the direct measurement of vector components of impedance, admittance, transfer function, power, vector magnitude and phase angle. Elimination of bridge balance enables measurements to be made rapidly and simply.

Main Frames: Three basic main frames are offered, each capable of analyzing a sinusoidal a-c voltage, producing readings and d-c outputs proportional to in-phase and quadrature components as well as magnitude and phase. Primarily designed for CW applications, the Series 100 can be used for limited gated-CW measurements where long duty cycles are present.

Model 100B Main Frame — measures in-phase* and quadrature components, of Z, Y and transfer function.

Model 100B - Mod 4 Main Frame — is similar to the 100B but includes internal emitter-follower of higher power capability.

Model 100C Main Frame measures in-phase and quadrature components, as well as magnitude and angle of Z, Y and transfer function.

Plug-In and Adapters: Eight separate units control or measure the alternating current or voltage applied to the unknown, scale the signals and apply them to the main frame for direct reading of the selected function.

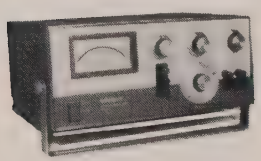
PLUG-INS AND ADAPTERS

Model 100-PA-	Measures	Freq. Range	Linear Ranges, Full Scale 1, 2.5, 5, etc. sequence	Voltage Across or Current Through Unknown (RMS)
1001A	Z & Y	100 Hz to 200 Khz	10Ω to 50 KΩ 10μ℧ to 50 Kμ℧	0-45 mv in Z mode; 3 v in Y mode
1004	Z	100 Hz to 200 Khz	1Ω to 5KΩ	0-45 mv
1008	Y or △Y	100 Hz to 100 Khz	100μ℧ to 500m℧	3 v
1009	Y or △Y	100 Hz to 10 Khz	0.025μ℧ to 10K μ℧	3 v
1010A	Z	100 Hz to 75 Khz	1Ω to 10KΩ	31.6A, 3.16KV max
1011B	Y or △Y*	100 Hz to 75 Khz	10 to 10^6μ℧ or pfd	31.6A, 6KV max
1012A	Y	100 Khz to 300 Khz	25μ℧, 2.5m℧, 250m℧	3 v
1013	V_o/V_1	100 Hz to 200 Khz	Gains of 0.01 to 10K	Input: 0.3 to 300 mv Output: 3 mv to 30 v

For further details on Series 100 write for bulletin 100
* Also used for dielectric measurements — measures capacitance and dissipation factor

SERIES 320

VECTOR IMPEDANCE AMPLITUDE METER



FEATURES:

- Direct reading of amplitude of impedance or transfer function
- Wide frequency range of 5 Hz to 500 Khz
- Wide impedance range of 1 to 10^7 ohms
- Impedance angle measurements (when Series 301 Phasemeter is used)
- Self contained oscillator

Series 320 Vector Amplitude Impedance Meters provide rapid, accurate direct measurements of impedance or transfer function. At premarked frequencies, inductance and capacitance are read from panel meter and a db scale facilitates Q measurements. Coupled with Series 301 phase meter, direct reading of impedance angle can be made easily.

APPLICATIONS:

- Rapid production and incoming inspection of resistors, capacitors and inductors
- Filter and network design and testing
- Amplifier impedance measurements
- General purpose signal generator

SPECIFICATIONS

Frequency Range: 5 Hz to 500 Khz
Impedance Range: 1Ω to 10 MΩ, in 7 ranges
Inductance Range: 1 μh to 100,000 h, in 11 ranges
Capacitance Range: 0.1 pf to 10,000 mfd, in 11 ranges
Amplitude Accuracy: 20 Hz to 100 Khz, better than 5% of reading; for frequency extremes, better than 7% at 5 Hz and 10% at 500 Khz.
Phase Accuracy: 20 Hz to 100 Khz, better than 2½°. Low frequency: 5 Hz, better than 4°. High frequency: 500 Khz, better than 5° at 10 to 10^8 ohms; for other values of Z, better than 10°.
Oscillator: 5 Hz to 500 Khz, 5 ranges, 3 v rms approx., ±3% frequency accuracy.
Signal across unknown: Below 1K Ω, < 35 mv rms. Above 1K Ω, approx. 3 v rms.
AC Outputs: Two, for connection to Series 301 Phase meter.
AC Power Input: 115 v, 50-400 Hz; other voltages available.
Size: Portable (320, 320A) 7″ x 16½″ x 11½″. For 19″ rack mount specify 320R or 320AR.
Weight: 18 pounds; shipping, 27 pounds.

OPTIONAL FEATURES

(Specify Model 320A or 320AR)

(1) DC output 0 to +1 v proportional to |Z| below 1K ohms, proportional to 1/|Z| above 1K ohms.
(2) DC output 0 to +1 v proportional to freq. dial position.
(3) AC output for use by counter for accurate freq. measurement.
(4) External oscillator input for use with special signal sources.

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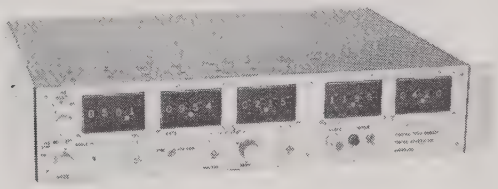
SERIES 206

DIGITAL GATING/TIMING GENERATOR



Series 206 GATING/TIMING GENERATORS gate the output of an a-c signal generator and provides a single signal burst or repetitive signal bursts, with turn-on and turn-off times coincident with zero crossings of the input signal to minimize switching transients.

Internal or external triggering initiates an accurate sequence of pulses for: (1) turning on the signal at its first positive going zero crossing; (2) turning off the signal at the first positive going zero crossing following a precise time interval; (3) delayed triggering of oscilloscopes or other devices; (4) gating detectors or receivers after a precise time interval; (5) delayed triggering of Dranetz Series 215 AC Sampling Voltmeters or Series 202 CW/Pulse Vector Component Computer systems.

APPLICATIONS:

- Automatic a-c testing of components and circuits.
- Testing of data communications systems, modems, multiplexers and switching circuits.
- Calibration of underwater transducers under tone burst conditions.
- Measurement of propagation and reflections in acoustical fields.

FEATURES:

- Wide frequency range of 50 Hz to 3 Mhz.
- Provides zero-crossing turn-on and turn-off of a-c signals, single or repetitive gating.
- Provides three additional independently selectable timing pulses for controlling gated detectors and receivers.
- Digitally-controlled timing from front panel controls.
- Remote programming option.

SPECIFICATIONS

MODES OF OPERATION:
CW
Gated: (for CW, FM or Phase-shifted signals).
Single shot or repetitive gating of AC signals.
Repetitive gating using internal timing oscillator (with or without sync. to 60 Hz power line).

SIGNAL CHANNEL:
Frequency range: 50 Hz to 3 Mhz.
Input: — Sinusoidal signal, 1 v rms ±10%.
Impedance—10 kΩ shunted by 100 pf.
Output: Level — Adjustable from 0.1 to 1 v rms into 75Ω load over full frequency range; adjustable from 0.5 to 5 v rms into 10kΩ up to 2 MHz.
Distortion — Less than ½% from 50 Hz to 0.5 Mhz; < 1% to 3 Mhz.
Input to output isolation: > 60 db to 0.5 Mhz; noise typically 60 db down.
Types of gating: Zero crossing turn on and zero crossing turn off; less than 1.5° or 25 nsec coincidence error. Non-synchronous turn-on and turn-off.

EXTERNAL TRIGGER:
Pulse or square wave input, ±5 v into 3 kΩ load, transformer input, rise time 50 μsec max, duration 50 μsec. min.

GROUNDING:
Separate chassis, circuit and power line grounds.

CONNECTIONS:
Connections on rear; monitor outputs on front.

CONTROLLED TIMING:
Repetition Period: 100 μsec to 99.99 sec.
Signal On-Time: 10 μsec to 9.999 sec.
Transient Delay Pulse: 10 μsec to 9.999 sec.
Receiver Delay: 10 μsec to 9.999 sec.
Receiver On-Time: 10 μsec to 9.999 sec.

OUTPUT CONTROL PULSES:
Sync. Output: +5 pulse at signal turn-on followed by −5 v pulse at delayed receiver turn-on.
Signal gate output (for use with commercial E-I Normalizers): +10 v rectangular wave, having leading edge coincident with signal turn-on and lagging edge coincident with signal turn-off.
Signal transient delay output: +10 v rectangular wave having lagging edge coincident with setting of Transient Delay Control.
Receiver enable output: +10 v rectangular wave having leading edge corresponding to Receiver Delay Control, and pulse width corresponding to Receiver On-Time Control.

INPUT POWER:
105 - 125 v 50 - 60 Hz, 40 watts.
SIZE: 3½" high x 17" wide x 15½" deep (with hardward for mounting in standard 19" relay rack).
WEIGHT: 20 pounds; shipping, 20 pounds.

PROGRAMMABLE UNIT MODEL 206A
Parallel BCD rear panel inputs for each timing control. Remote operation on zero position of manual controls. Switch closure to ground or application of 0 to +0.8 v dc is binary one; open circuit or application of +2 to +5 v dc is binary zero. For switch closure, Model 206A produces 3.2 ma dc max. For manual setting of controls, rear connectors produce BCD outputs corresponding to control positions.

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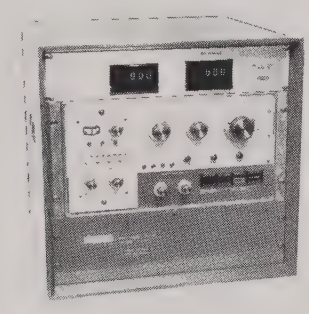
SERIES 202

SAMPLING VECTOR COMPUTING SYSTEMS

For pulsed or CW measurements of Complex Impedance, Admittance, Phase, Transfer Function and Power



FEATURES:

- Computing time less than 1 cycle after sample
- Computes real and imaginary components, phase and magnitude
- Measures CW, gated CW or rapidly varying AC signals
- Selectable sampling times — 0.5 to 500 ms
- Single burst measurements — sample and hold outputs
- Analog and Digital readouts
- Plug-in concept for broad versatility
- Internal delay to eliminate transients
- Differential measurements for high accuracy

APPLICATIONS:

- Automatic high speed testing of components
- Measurement of electro-acoustic transducers under low and high power
- Use as phase-lock detector for low level signal bursts
- Analysis of acoustical fields
- Measurement of real and imaginary input power

The 202 Vector Computing System provides real time computation of vector components, phase and magnitude, requiring only a single sample of the AC test signal and AC reference for measurement. Direct reading digital and analog displays are produced, with provision for connection to X-Y or strip chart recorders or digital computers.

Consisting of a Model 202 or 202A Main Frame, a selectable plug-in and a readout unit, this system can be used for direct computation of impedance, admittance and transfer function under a wide range of voltages, currents and frequencies.

Its rapid computing speed is designed for simultaneous graphic recording of all four outputs, and is particularly useful for frequency plotting or complex immittance plane recording. Yet its sample and hold outputs are excellent for single burst measurements. Measuring on external command, this system is well suited for automatic high speed testing of components as well as complete network analysis.

VECTOR COMPUTER MAIN FRAMES 202 and 202A

Heart of a 202 system is the Vector Computer Model 202 or 202A. The Model 202 accepts two normalized AC signals from the plug-in, producing DC voltages proportional to real and imaginary components. In addition, the Model 202A also produces simultaneously DC voltages proportional to magnitude and phase. Utilizing a unique sampling and integrating technique, effects of noise and harmonics are considerably reduced as compared to systems which utilize peak reading techniques for magnitude and zero axis crossings for phase.

PLUG-INS:

Plug-ins 202-PA-2505 and 202-PA-2506 are for general purpose use, and complement each other to cover a frequency range of 100 Hz to 10 Mhz. Each consists of a plug-in section and a probe unit, with 10 ft of cable. Model 202-PA-2505 measures up to 5,000 v rms, and is completely programmable by computer. Model 202-PA-2506 covers the complete 150 Khz to 10 Mhz band without frequency band switching.

Both units are capable of the unique Dranetz differential admittance measurement as well as impedance and transfer function. Both plug-ins also provide auto-ranging of the DVM's on the Model D12 readout.

READOUTS:

Two panel readouts are available. Model D10 provides two 5″ analog meters, mounted with accessory circuits, on a 5¼″-high panel for 19″ rack mounting. Model D12 (shown in photo) consists of two direct reading digital meters, with BCD outputs mounted on a 3½″-high panel for 19″ rack mounting.

MAIN FRAME SPECIFICATIONS

Repetition Rates:

A. On CW, automatic recycling at approx. 10 samples/sec.

B. On gated AC, externally triggered, from 100 samples/sec to 1 sample per 200 seconds.

C. Single pulse operation.

Sampling Times: selectable from 0.5 to 500 ms; 4 - 8 cycles min.

Hold Times: up to 3 minutes.

Inputs:

A. Signal power: see E-I limits, plug-in chart, below.

B. Command (not required for CW). 5 v pulse or gate into 3KΩ, related to turn on of signal source.

DC Outputs (all simultaneous):

A. (202 and 202A): 0 to ±5 v fs, proportional to real and imaginary components.

B. (202A only): 0 to ±1.80 v proportional to 0 to ±180°. 0 to 1 v fs proportional to magnitude.

Monitor & Command Outputs:

Signal or pulse outputs for AC signal monitoring and sampling time presentation, Z axis scope intensification, scope synch, pen lift, out-of-limit disabling, and blanking.

Front End Plug-Ins:

Accommodates all Dranetz Series 202-PA-plug-ins directly and all Dranetz 100-PA-plug-ins by use of adapters 202-PAR-2501 and 100,713.

Readout Compatibility:

Compatible with analog DC meters (e.g. Dranetz Model D10), Digital meters (e.g. Dranetz D12), oscilloscopes, X-Y recorders and A-D converters.

Input Power: 105 - 125 v, 60 Hz, 120 watts max.

Mechanical:

A. Size: 8¾″ high x 17″ wide x 18″ deep (will fit into 24″D hatch). Carrying handles and slides for 19″ rack mounting.

B. Weight: 56 pounds; shipping 95 pounds.

PLUG-IN SPECIFICATIONS

Model	Measuring Function	Freq. Range	Z - Y Ranges	E-I Limits	Nominal Accuracy *	Operation	Probe Size
202-PA-2505	Impedance, Differential Admittance and Transfer Function	50 hz to 300 Khz	Z: 1 to 10^5 Ω Y: 10 to 10^4 μ℧	1 - 5000 v rms 10 ma - 30 A rms	±2° phase ±2% fs Amplitude	Manual and Programmable	3½″x12″x12″
202-PA-2506		150 Khz to 10 Mhz	Z: 2.5 to 10^4Ω Y: 10 to 25 K μ℧	1 - 100 v rms 1 ma - 1 A rms	±2° phase ±2% fs Amplitude	Manual	3″x4″x6″

* Higher accuracy in differential mode

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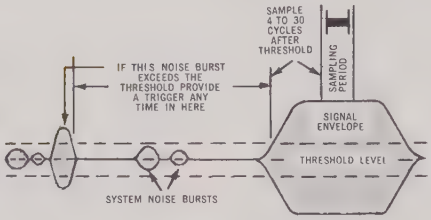
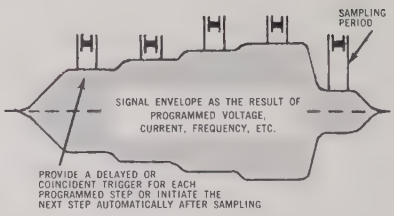
SERIES 215
AC SAMPLING VOLTMETER


SAMPLE 4 TO 30 CYCLES AFTER THRESHOLD
SAMPLING PERIOD
IF THIS NOISE BURST EXCEEDS THE THRESHOLD PROVIDE A TRIGGER ANY TIME IN HERE
SIGNAL ENVELOPE
THRESHOLD LEVEL
SYSTEM NOISE BURSTS


SAMPLING PERIOD
SIGNAL ENVELOPE AS THE RESULT OF PROGRAMMED VOLTAGE, CURRENT, FREQUENCY, ETC.
PROVIDE A DELAYED OR COINCIDENT TRIGGER FOR EACH PROGRAMMED STEP OR INITIATE THE NEXT STEP AUTOMATICALLY AFTER SAMPLING

Measures average value of signals in sampling periods as short as 100 μsec.

FEATURES:

- Selectable sampling periods
- Internally delayed or externally triggered sampling for measurement of any selected portion of signal waveforms
- Excellent noise discrimination during signal measurement
- Can be triggered externally or by internal sensing of signal
- Sample and hold d-c output for DVM or a-to-d conversion and automatic print out
- Frequency range of 100 Hz to 1 Mhz
- Sampling rates to 2,000 per second
- For use to 5,000 vrms, 50 Amps rms with available probes

APPLICATIONS:

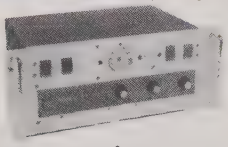
High speed component testing; analysis of time varying or transient effects; measurement of direct or reflected acoustical signals; and measurement and control of signal burst levels applied to radiators or receivers (when used with Dranetz Series 501 Servo Control Unit).

Series 215 is a true averaging AC voltmeter for rapid sampling and analysis of complex A-C signals in the form of single transients, repetitive voltages or multiplexed signals. Its unique integrating design makes possible averaged measurements within a time as short as one cycle and provides discrimination against background noise and spikes.

SPECIFICATIONS

Frequency Range: 100 Hz to 1 Mhz
Input Impedance: 1M ohm, shunted by 50 pf
Input Signal Levels: 6 voltage ranges, 0.1 to 5 vrms, fs
For extended ranges use one of the following probes:
Tektronic Models: P6006 (1-50 vrms), P6007 (10-500 vrms), P6013 (100-5,000 vrms);
Dranetz Models: TR2004 (1-50 A rms), TR-2005 (0.1-5A rms), Threshold adjustable 4-20% fs.
Input Circuit Configurations: single ended, floating ground; differential.
Repetition Rates:
CW: 10 samples/sec with internal generator
Gated AC: 1 sample/2.5 sec to 1,000 samples/sec, without internal delay; with internal delay, 20 msec minimum off-time required between pulses.
Triggered Input: square wave, pulse or step, ±5 v peak.
Single Shot: Output changes to 99% of change from previous reading. Shift less than 1% FS/minute.
Sampling Periods: 0.1, 1 and 10 msec. Requires min of 1 full cycle.
Delay Control to Mask Transients: External or Internal. Controlled on internal, 4 to 30 Hz delay, selectable, below 0.5 Mhz; 6 to 60 μsec delay above 0.5 Mhz.
Accuracy: ±2% at reading, ±½% fs, single ended input.
Monitor and Control Outputs: Synchronizing pulse (+10 v, 39kΩ) for external equipment; Monitor output: 2 v p-p with 0.5 v pedestal indicating sampling time.
Output Indication: Panel meter calibrated in rms. DC output 0-5 v fs, drives > 10K ohm load.
Indicating lamps: For overload, correct sampling and sampling period.
Input Power: 115 v, 50-60 Hz, 18 watts.
Size: 12" x 3½" x 15½" deep, equipped for 19" rack mounting.
Weight: 16 lbs; shipping, 25 lbs.

SERIES 501A
SERVO CONTROL UNIT



FEATURES:

- Precision control of signal level
- Broad frequency range of 100 Hz to 1 MHz
- Wide dynamic range of 60 db
- Ground isolation of signals

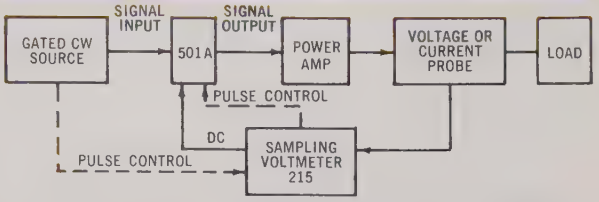
APPLICATIONS:

- For CW and gated CW control
- Measurement of complex impedance and admittance under high power
- Constant level control for acoustical calibrations
- Vibration amplitude control for mechanical impedance measurements
- Parameter control in programmed industrial process systems.

Series 501A Servo Control Unit maintains the level of a signal at a precise value, regardless of fluctuations in source level or load. By proper scaling of signals the unit will control voltage, power, acceleration, velocity, displacement, pressure or other physical functions. The 501A's servo system senses the voltage at a sampling point, compares it with an internal reference voltage and controls the position of a precision potentiometer, to adjust the voltage to a predetermined level.

SPECIFICATIONS:

Modes of Operation:
(1) CW (2) CW or Gated CW when used with Dranetz Model 215
Frequency Range:
(1) CW: 100 Hz to 100 kHz (2) CW or Gated CW with Dranetz Model 215: 100 Hz to 1 MHz



CONSTANT VOLTAGE OR CURRENT CONTROL FOR GATED CW SYSTEM

Signal Input: Voltage level, 3 v rms max. Input impedance, 2 kΩ, approx. Leads: 2 wire, single-ended, both isolated from ground.
Signal Output: Level: From 0 to 60 db below input level. Input impedance of equipment following (e.g., power amplifier) should be 10kΩ or higher. Input leads to amplifier: 2 wire, single-ended.
Feedback Control Voltage or Current: CW (w/out Model 215), between 0.5 and 5 v rms into 50,000 ohms. CW or Gated CW (w/Model 215): Same current and voltage range as 215 with or without probes. (See above).
Control Characteristics: Dynamic range: 60 db. Level control — Maintains feedback control voltage within ±2% up to 500 Khz for change in input signal or power amplifier load of ±30 db. Response time — Approx. 0.5 sec.
Oversignal Protection: Automatic signal cutoff for over-level signals.
Power Required: 115/230 v, 60-400 hz, 0.6 amps rms.
Size: 7" high x 16½" wide x 11½" deep equipped for mounting 19" rack. **Weight:** 25 lbs.; shipping, 40 lbs.

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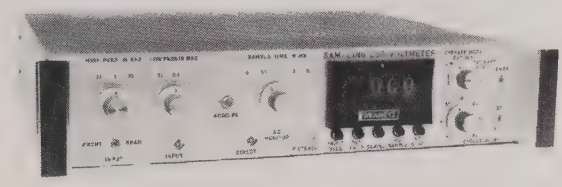
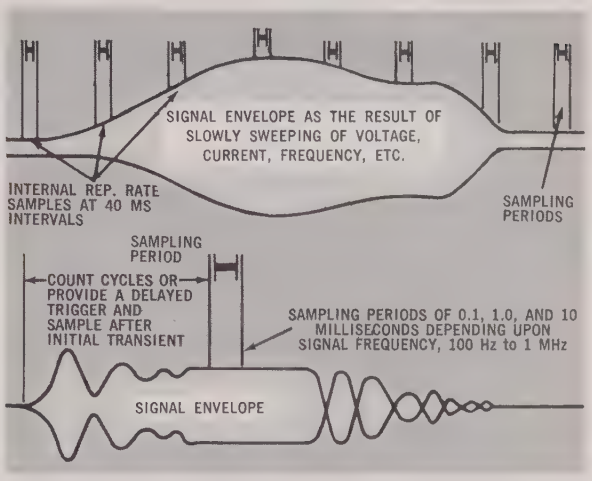
SERIES 220
LOG SAMPLING VOLTMETER

Direct digital readout of CW, Gated AC, or rapidly varying AC signals




SIGNAL ENVELOPE AS THE RESULT OF SLOWLY SWEEPING OF VOLTAGE, CURRENT, FREQUENCY, ETC.
INTERNAL REP. RATE SAMPLES AT 40 MS INTERVALS
SAMPLING PERIODS
SAMPLING PERIOD
COUNT CYCLES OR PROVIDE A DELAYED TRIGGER AND SAMPLE AFTER INITIAL TRANSIENT
SAMPLING PERIODS OF 0.1, 1.0, AND 10 MILLISECONDS DEPENDING UPON SIGNAL FREQUENCY, 100 Hz to 1 MHz
SIGNAL ENVELOPE

FEATURES:

- Frequency range - 100 Hz to 1 Mhz
- Sample and hold output - analog and digital outputs
- Single or repetitive measurement to 1000 samples per second
- Sampling times down to 100 μsec
- Output independent of sampling time or duty cycle
- 84 db dynamic range - 300 μv to 5 v (to 5 kv with voltage probes)
- Logarithmic digital display and BCD outputs
- Complete programmability for either remotely controlled or computer controlled test systems

APPLICATIONS:

- High speed component testing
- Analysis of time-varying or transient effects
- Measurement of direct or reflected acoustical signals
- Measurement of signal burst levels applied to radiators or receivers.

The Model 220 Sampling Voltmeter is a gated, average responding voltmeter for measuring amplitude of AC signals during a short sampling time. Measurement can be made of rapidly varying CW signals, gated AC signals (tone bursts), or single shot AC signals. Measurements are made at any predetermined time in a selected period which can be as short as 1 cycle of the signal.

Sample and hold output circuitry, combined with internal logarithmic conversion, provide several simultaneous outputs: a digital panel meter reading directly in DBV (ref: 0 DBV = 1 v rms), a linear DC output, two logarithmic DC outputs, and a logarithmic digital output (BCD code) corresponding to the digital panel meter reading. Provision is made for insertion of an external DC signal which allows both the digital display and BCD output to correspond to other logarithmic parameters without effecting instrument calibration.

This instrument combines internal low and high pass filtering, a unique average responding detector, and logarithmic conversion to offer an exceptionally wide dynamic range, high sensitivity, wide frequency range, short sampling time and low susceptibility to noise and signal distortion compared to peak responding AC instruments.

SPECIFICATIONS

Signal Frequency Range: 100 Hz to 1 Mhz

Accuracy: ±0.3 db to 200 Khz, ±0.5 db 200 Khz to 1 Mhz

Resolution: Analog output - infinite Digital readout and output: 0.1 db

Dynamic Input Range: −70 to +14 dbv (ref. 0 dbv = 1.0 v rms) (0.3 mv to 5 v rms)

Input Circuit Configuration: Single ended, front and rear panel input jacks (BNC)

Signal Input Impedance: 1 megohm

Output Indication: (1) Digital panel meter: −70 to +14 dbv, ±199.9 db max. indication with external DC scaling input (2) DC analog outputs, Zo = 600Ω, drives 10kΩ min. load resistance:

A. Log, 0.05 v/db, +0.0 to +4.2 v out

B. Log, 1mv/db −70.0 mv to +14.0 mv (0 v dc out ref 1 vrms in)

C. Linear, +0.5 to +5 v dc

(3) BCD outputs, 12 lines (8-4-2-1 BCD)

Repetition Rate: Internal trigger generator approx. 10 samples/second. External trigger: 1 to 4 ms required between samples for analog DC outputs depending upon sample time; 10 msec min repetition rate for digital display and BCD outputs.

Sampling Period: Periods approx. 0.1, 0.3, 1, 3 and 10 msec. Requires min of 1 full cycle.

Filters: 0.1, 1 and 10 Khz high pass; 0.01, 0.1 and 1 Mhz low pass.

Sample and Hold Facility: Output transfers from level to level without discharge. DC outputs drift less than 0.2 db per minute after last sample. Digital output can be programmed for infinite hold.

Trigger Input (to initiate sampling): Square wave, pulse, or step, ±5 v peak, rise time < 50 μsec (10-90%) transformer input, ungrounded, input impedance approx. 5k ohms.

Delay Control to Mask Signal Transients: Below 0.5 Mhz, selectable cycle count 4 to 300 cycles; above 0.5 Mhz, selectable time delay of 8 to 600 μsec.

Monitor and Control Outputs: (1) Synchronizing pulses for external equipment. (2) AC monitor outputs: Filtered and unfiltered signal level approx. 2V pk-pk; filtered output has 0.5 volt pedestal indicating sampling time. (3) Fault indicating signals available at rear panel.

Visual Indicators: For overloads, correct sampling, sampling period, low and high pass filter selection, incorrect sampling and loss of signal input.

Compatibility: Compatible with Dranetz Gating/Timing Generator 206, and other pulse generators.

Programmability (rear connectors): Compatible with DTL and TTL; also operable by remote contact closures. Filter selection, sample period, timing and other functions are programmable.

AC Input Power: 115v, 50-60 Hz, 35 watts

Size: 3½" high x 17" deep x 17" wide equipped for 19" rack mounting.

Weight: 25 lbs.; Shipping, 35 lbs.

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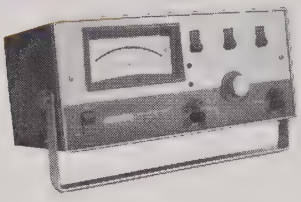
SERIES 301 PHASE METERS



FEATURES:

- 70 db input level range
- 1° accuracy, 0.1° resolution
- 5 Hz to 0.5 Mhz frequency range
- 0° to 360° phase range
- 0 to 3.6 vdc analog output

Series 301 Phase Meters are low cost, direct-reading instruments for measurement of the phase difference between two sinusoidal signals.

Phase angle is indicated by a large taut band meter with mirror scales of 0 to 36, 0 to 90, 0 to 180, and 0 to 360 degrees. The 70 db input range of the 301 is achieved without range switching. Operating controls include an input reversal switch and an "Add 180°" switch which allows the operator to avoid the 0°/360° discontinuity. Model 301A also produces a DC voltage output proportional to angle.

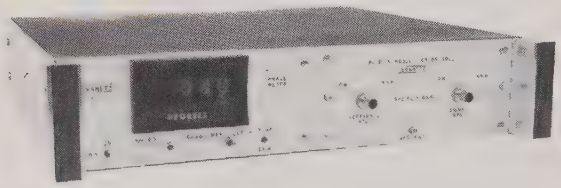
SPECIFICATIONS

Frequency Range: 5 Hz to 500 Khz
Input Impedance: 100 KΩ
Absolute Accuracy (independent input levels):
±1°, 45 Hz to 40 Khz, inputs > 200 mv
±1.5°, 7 Hz to 100 Khz, inputs > 200 mv
±2°, 5 to 7 Hz and 100 to 200 Khz
1° additional for each additional 100 Khz
Minimum Input Levels:
1 v rms, 5 Hz to 30 Hz
300 mv rms to 50 mv rms, 30 Hz to 200 Hz
50 mv rms, 200 Hz to 50 KHz
50 mv rms to 500 mv rms, 50 Khz to 500 Khz
Maximum Input Levels:
160 v rms
Panel Meter:
6" taut band movement
0.5% fs linearity (add to accuracy)
Rectangular Wave Output: 1.5 v p-p, 5 nsec rise time
DC Output (Model 301A or 301AR only):
0 to +3.6 vdc for 0 to 360°
Z out less than 50Ω
AC Power Input: 115/230 v 50 to 400 Hz, 0.4 Amps rms
Case:
7" x 16½" x 11½". For 19" rack mount specify option R.
Weight: 18 lbs.; shipping, 27 lbs.

SERIES 302 PHASE METERS

Series 302 Phase meters have all of the features of Series 301A instruments with the addition of an easy to read Digital Display. Display ranges are 0 to 180° and 0 to 360°, with resolution up to 0.1°. Readout accuracy is ±0.2°. Analog output is standard on all 302 series instruments. In addition, BCD outputs are available. Except for the above differences, 302 specifications are identical to those of the 301 Series.

SERIES 305 PHASE METERS



FEATURES:

- No operating controls
- Excellent stability — no adjustments
- 0.1° accuracy independent of input voltage
- Versatile plug-in concept
- Rejects harmonics, distortion and noise
- Digital readout and outputs

Series 305 Phase meters represent a totally new concept in the measurement of phase angle. A precision phase angle measurement requires only connection of the signals and reading the 4 digit display. The 305 senses signal frequency and adjusts its output time constant for maximum speed commensurate with low ripple. Its unique design locks out high frequency noise. This instrument is also insensitive to waveform distortions which can cause errors of as much as 0.6° per % distortion in other instruments.

Three main frames provide a selection of outputs suited to the individual need. Two plug-ins available are: the Model 305-PA-3001, which achieves exceptional accuracy over a broad dynamic range by "auto ranging" in each channel; and the 305-PA-3002, with high accuracy over limited dynamic ranges. Other plug-ins can also be furnished.

SPECIFICATIONS — SERIES 305 MAIN FRAMES

MODEL 305 PHASE TO DC CONVERTER

Analog Output: −1.800 to +3.600 vdc. 10 mv/degree sensitivity. Time constant variable from 10 to 700 ms by signal freq.
Output stability: ±0.1° per month
Operating Modes: Zero to +360° and 0 to ±180°. Automatic switching at <−160°, >+160°, <+20°, and >+340°
Self-Check: −180°, Zero, +180°, and +360°
Error Rejection: False triggers due to high frequency noise are locked out for signal to noise ratios better than 10:1. Errors and fluctuations due to waveform disymmetry or low frequency noise reduced by at least 10:1
Input Power: 115 v - 50-400 Hz - ½ Amp.
Size: 3½" rack/portable package; 16" depth.
Weight: 20 lb.; shipping 30 lb.

MODEL 305A PHASE METER

Same as Model 305 with the addition of 3½ digit readout: 0 ±180.0° indication with −180° offset for coverage of +180° to +360°. ±0.2° accuracy (add to basic accuracy).

MODEL 305B PHASE METER

Same as Model 305 with the addition of full 4 digit readout: −180.0° to +360.0° indication. ±0.15° accuracy (add to basic accuracy). 1248 BCD Outputs. Read and hold on command.

305 SERIES PLUG-IN SPECIFICATIONS (WHEN IN MAIN FRAME)

Model	Freq. Range	Input Levels[1] (independent)	Accuracy[2] (w/independent level)
305-PA-3001	5 Hz to 500 Khz[3]	10 mv to 50 v rms direct; can be extended to 40 Kv rms with Tektronix probes.	±0.1°, 50 mv to 50 v rms from 50 Hz to 50 Khz
305-PA-3002	5 Hz to 500 Khz[3]	10 mv to 500 mv rms direct; can be extended to 500 v rms with Tektronix probes.	±0.1°, 50 mv to 500 mv rms from 50 Hz to 50 Khz

[1] Other levels available on special order.
[2] For sinusoidal signals; can be used with square wave inputs over limited frequency range. Contact plant for further information.
[3] Frequency limited by plug-in. Higher frequency plug-ins also available (up to 10 MHz).

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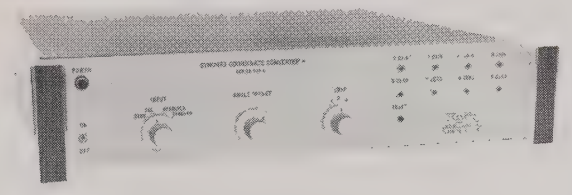
SERIES 506, 506A
SYNCHRO COORDINATE CONVERTERS



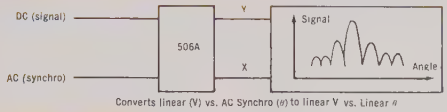
Series 506 and 506A Synchro Coordinate Converters, through the use of coordinate transformation techniques, convert an X-Y recorder into a synchro recorder for plotting polar and rectangular beam patterns (signal levels vs. synchro shaft angle).

FEATURES:
- Synchro angle offset control
- No moving parts
- Front panel zero and calibrate controls
- Compatible with most 60 Hz synchros such as 15CX6, 23TX6 (400 Hz units also available)

APPLICATIONS:
- Antenna testing
- Range and bearing plotting
- Calibration of underwater and airborne acoustical devices
- Measurements of electromagnetic and acoustical fields

SPECIFICATIONS

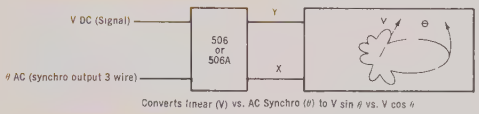
Rectilinear Beam Plots (506A only)



Converts linear (V) vs. AC Synchro (θ) to linear V vs. Linear θ

DC Signal Input: Direct feed thru to recorder
AC Synchro Input: 115/90 v 60 Hz, 1X (36x usable for highest accuracy)
X Output: 0 to +4.5 vdc
Full Scales: 18° and 36° with 36X synchro; 90°, 180° and 360° with 1X synchro.
Acuracy: ±0.02° for 18° and 36° scales; 0.15° for 90° and 180° scales; ±0.3° for 360° scale.

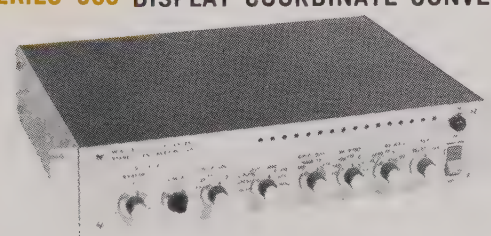
Polar Beam Patterns (506 or 506A)



Converts linear (V) vs. AC Synchro (θ) to V sin θ vs. V cos θ

DC Signal Input*: 0 to +5 vdc
AC Synchro Input: 115/90 v 60 Hz, 1X
Y Output: ±(0 to 2.2 v) from origin of +1.4 v
X Output: ±(0 to 2.2 v) from origin of +2.2 v
Accuracy: ±1% fs Radius; ±1° in angle
AC Power Input: 115 v, 60-400 Hz, 0.1 amps rms approx.
Mechanical — Size: 3½" high x 17" deep x 19" wide for rack mounting
Weight: 18 pounds; shipping, 27 pounds

SERIES 505 DISPLAY COORDINATE CONVERTER

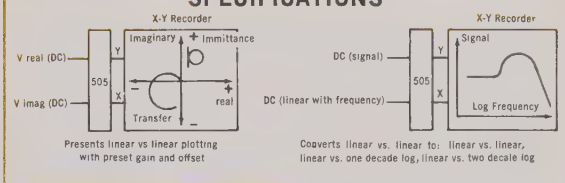


Series 505 Display Coordinate Converter is an interface device which provides coordinate transformation of inputs for plotting on X-Y recorders. It performs an integrated series of functions, selectable by a front panel mode switch. Depending on the recording mode chosen, the 505 selects the proper coordinate system, sets the gains, and injects the proper axes offsets in accordance with preset controls. In addition, the operator may select special conditions for his application, such as scale expansion of signal level or synchro angle, or axis offset of the signal input.

The Series 505 Display Coordinate Converter performs all of the functions of the Series 506 and 506A. In addition the 505 has provisions for plotting one function against the log of a second function (e.g.: output vs log frequency), as well as plotting x-y data.

APPLICATIONS:
- Complex plane or other X-Y plots, imaginary vs. real, or other DC vs. DC signals.
- Response
  Level, phase or immitance vs. frequency, log frequency or other functions
- Response Reference Comparison
  Provision for subtraction of curve follower output from input signal for recording deviation from precalibrated standard.

SPECIFICATIONS



Rectilinear Beam Plots (Same as for 506A)
Polar Beam Patterns (Same as for 506 & 506A)
Linear vs. log
DC Signal Input* 0 to +5 vdc**
DC (Frequency) Input* 0 to +10 vdc; +1 to +10 v for one decade log; +0.1 to +10 v for two decade log
Y Output: 0 to +2.5 vdc, adjustable
X Output: 0 to +5 vdc, adjustable
Accuracy: Linear ±0.1% fs; Log ±1% of reading
Calibrated offsets from −40 db to +20 db in steps of 10 db, and selection of 20, 50 and 100 db full scale on the Y axis when using dc logarithmic input signal (e.g. from Dranetz Model 220 Log Sampling Voltmeter).
Linear X-Y Plotting
DC Inputs*: Two - each ±5.0 vdc
X & Y Outputs: each 0 to +2.5 vdc, adjustable
Accuracy: ±0.1% fs
Suitable for use with Dranetz 202 or 202A Vector Component Computer
AC Power 115 v, 60-400 Hz, 0.1 amps rms
Size: 3½" high x 17" deep x 19" wide for rack mounting
Weight: 18 pounds; shipping, 27 pounds

* Suggested levels — will accommodate ±25% gain and offset variation.
** Additional input for subtration of curve follower output. −5 vdc (regulated) available for connection across curve follower potentiometer.

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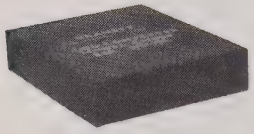

Series CM Computing modules consists of the CM-1000 DC Log Amplifier; CM-1100 Phase Generator; CM-1200 Phase to DC Converter and CM-1300 Phase Sensitive Detector. All are packaged in low-profile, flat package for printed circuit mounting.

CM-1000-40, CM-1000-60 DC LOG AMPLIFIERS

The CM-1000 Log Amplifier transforms DC signals to an output voltage proportional to the logarithm of the input voltage. With input from 0.1 to 10 volts (40 db range), the output error is less than ±0.15 db from the specified equation $V_{out} = 5 + 5 \log V_{in}$ volts. From 0.01 to 10 volts (60 db), the error is less than ±0.2 db. The unit is usable over an 80 db range at slightly reduced accuracy by the use of external trimming. Internal temperature regulation provides tight control of the log characteristic over the specified temperature range. The gain and offset are also externally programmable.

FEATURES:

- Programmable gain and offset
- 25 microseconds response time
- 80 db dynamic range

APPLICATIONS:

- Signal Conditioning
- Log Conversion — db output
- Spectrum Analysis
- Useful for scaling DVM's

CM-1100 AND CM-1110 SYNCHRO TO PHASE CONVERTERS

The Model CM-1100 converts the output of a 3-wire or 4-wire synchro to variable phase square waves. This module, using an AC reference, produces three square wave outputs: a reference signal, a quadrature signal (a signal shifted 90° from reference) and a signal shifted by an angle equal to the shaft angle. The CM-1110 is similar to the CM-1100 except that it does not produce reference outputs and is intended for systems where the reference is already available. If grounding of one side of a 4-wire synchro resolver is permissible, the Phase Generator will operate from the 4-wire resolver through an isolation network (see data sheet). When used with a 3-wire synchro or torque transmitter, a Scott-T transformer must be employed. Used with a CM-1200 or CM-1300 module, the phase generator will convert a synchro signal to a DC analog, or to sin and cos functions for rectangular coordinates. Its new conversion method features matched phase shift networks for variable and reference signals to assure an accurate output. Matched filters for the reference and variable channels makes the phase generator insensitive to noise or distortion. High input and low output impedances minimize system loading effects.

FEATURES

- Noise and waveform filtering
- Modules with and w/o reference phase
- Compatible with CM-1200 and CM-1300

APPLICATIONS:

- Signal Conditioning
- Polar to Rectangular Conversion
- Synchro to Analog Conversion
- Synchro to Digital Conversion

CM-1200 AND CM-1210 PHASE TO DC CONVERTERS

The CM-1200 series module converts an input of two square waves of the same frequency to a DC output proportional to the phase between the signals. The Model CM-1200 produces full scale output for 360°, 720°, to 1440°, selectable by means of external jumpers, and including provision for externally resetting the output to correspond to less than 360°. The CM-1210 produces a single full scale output for 360°. When used with a CM-1100 module, the two combine to convert a synchro output to a DC signal proportional to shaft angle.

The input drive is compatible with CM-1100 or TTL logic levels.

FEATURES

- Programmable Ranges 360°, 720°, 1440°
- Compatible with CM-1100

APPLICATIONS:

- Signal Conditioning
- Synchro to Digital Conversion
- Synchro to Analog Conversion

CM-1300 PHASE SENSITIVE DETECTOR

The CM-1300 series Phase Sensitive Detector produces DC outputs corresponding to real and imaginary components of an AC signal, using as inputs, three phase related square waves and a DC level. The outputs from the CM-1300 are equivalent to E cos θ and E sin θ. Internal gain and offset adjustments for each output channel are preset at the factory. Provisions are made for external changes of these settings. Internal filters provide maximum harmonic rejection.

FEATURES

- Compatible with CM-1100
- Modules available for 60 or 400 Hz operation
- Harmonic Rejection

APPLICATIONS:

- Signal Conditioning
- Navigation Plotting
- Transducer Pattern Measurement
- Antenna Pattern Recording
- Polar to Rectangular Conversion

For application information on any of the CM MODULES, request specific bulletins.

FEATURES:

- Temperature stabilized
- Integrated circuit design
- Reverse voltage protection
- Printed circuit mounting
- 32-125°F operating temperature range
- Meet MIL-E-16400
- Input Power: ±15 Vdc ±2%

SPECIFICATIONS

Input Signal CM-1000-40 - +0.1 to +10 v
CM-1000-60 - +0.01 to +10 v
Input Impedance: 50 K ohms
Output Signal (DC): Single Ended (0.25 V/DB)
CM-1000-40 — 0 to +10 v and 0 to −10 v
CM-1000-60 — −5 to +10 v and +5 to −10 v
Push Pull: Center tapped at ground
CM-1000-40 — 0 to +20 v, or 0 to −20 v (0.5 v per db)
CM-1000-60 — −10 v to +20 v, or +10 v to −20 v (0.5 v per db)
Output Impedances: 75 ohms approx
Output Loads: 10 K ohms and higher
Accuracy: CM-1000-40 — ±.15 db referred to input
CM-1000-60 — +.2 db referred to input
Response time for 20 db step: 25 microseconds (slew rate of 200 v/ms)
Temperature Coefficient: <.006DB/°F
Package Size: 3″ x 2.5″ x 0.625″
Weight: 4 ounces

SPECIFICATIONS

Signal Input Levels (Simultaneous):
#1, 3 v ±10% AC (representing sine of shaft angle)
#2, 3 v ±10% AC (representing cosine of shaft angle)
#3, 3 v ±10% AC Reference (CM-1100 only)

Output:
#1, 20 v p-to-p square wave (phase variable with shaft angle)
#2, (CM-1100 only) 20 v p-to-p square wave locked in phase with reference signal
#3, (CM-1100 only)20 v p-to-p in quadrature with output #2

Accuracy: ±12 minutes of arc

Temperature Coefficient: ±0.01 minutes of arc per °F

Slew Rate: 1000°/second at 60 Hz — 7000°/second at 400 Hz

Frequency: CM-1100-60 and CM-1110-60, 60 Hz, ±5%
CM-1100-400 and CM-1110-400, 400 Hz, ±5%

Output Load: 2KΩ or higher (DC coupled)

Size & Weight: 3″ x 4.5″ x 0.625″; 7 oz.

SPECIFICATIONS

Input Signals: Reference & Variable Phase
A. Direct Coupled from CM-1100 or any phase related pair of square wave signals 15 v p-p to 25 v p-p
B. TTL logic levels (+4 and 0 v, 4 ma sinking logic)
Input Impedance: A. 2K; B. 4 ma sinking logic at 0 v.
DC Output Signal: +3.6 volts full scale (provisions for external adjustment of offset and gain)
Output Impedance: 50 ohms maximum
Range: CM-1200: 0 - 360°, 0 - 720°, or 0 - 1440° CM-1210: 0 - 360°
Temperature Coefficient: ±0.005% FS per °F
Frequency: CM-1200-60 and CM-1210-60: 60 Hz ±5%
CM-1200-400 and CM-1210-400: 400 Hz ±5%
Rise/Fall Time (10% - 90% points): CM-1200-60: 200 ms
CM-1200-400: 30 ms
Accuracy: ±12 minutes of arc per 360 degree cycle
Size and Weight: 3″ x 4.5″ x .625″ — 7 oz.

SPECIFICATIONS

Input: #1, 20 v p-to-p square wave variable phase
#2, 20 v p-to-p square wave reference phase
#3, 20 v p-to-p square wave in quadrature with #2
#4, 0 to +5 v dc

Output: E Cos θ, 0 to ±10 vdc; E Sin θ, 0 to ±10 vdc

Frequency: CM-1300-60: 60 Hz ±5%; CM-1300-400: 400 Hz ±5%

Accuracy (at 25°C): ±1 degree (angle); ±2% fs (Magnitude)

Temperature Coefficient: Magnitude: ±0.05% fs per °F

Size & Weight: 3″ x 4.5″ x 0.625″; 7 oz.

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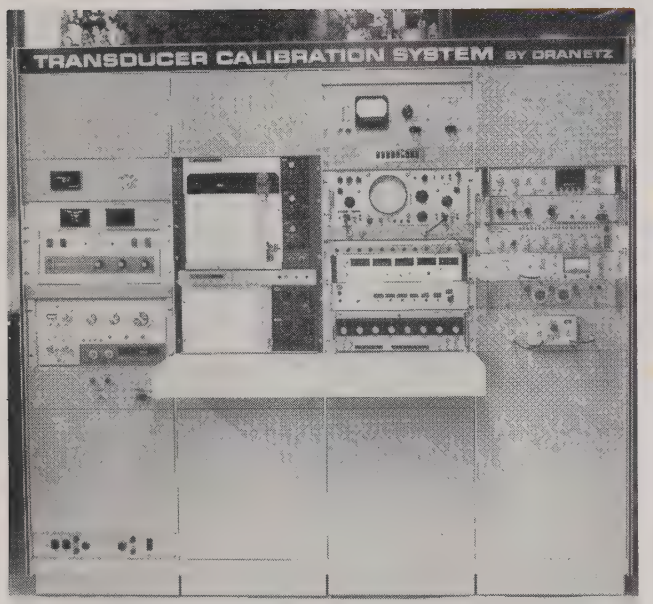
DRANETZ SYSTEMS CAPABILITIES

The Dranetz Engineering Laboratories staff of engineers has over the years developed extensive, expertise and capability in the development and manufacture of custom systems to users specifications. These systems include rugged and reliable equipment for ship-board and shore-based Naval installations as well as systems for rapid and accurate testing of electronic components. These systems can be furnished for manual operation or with complete computer control depending on the users desire. In the manufacture of these systems, Dranetz uses either its own family of highly reliable and accurate instrumentation or instruments manufactured by other companies and or a combination of both. Considerable experience in systems design and manufacture has been developed in the following areas.



This is a complete system for evaluation of Sonar Hydrophones & Projectors.

TRANSDUCER CALIBRATION SYSTEMS

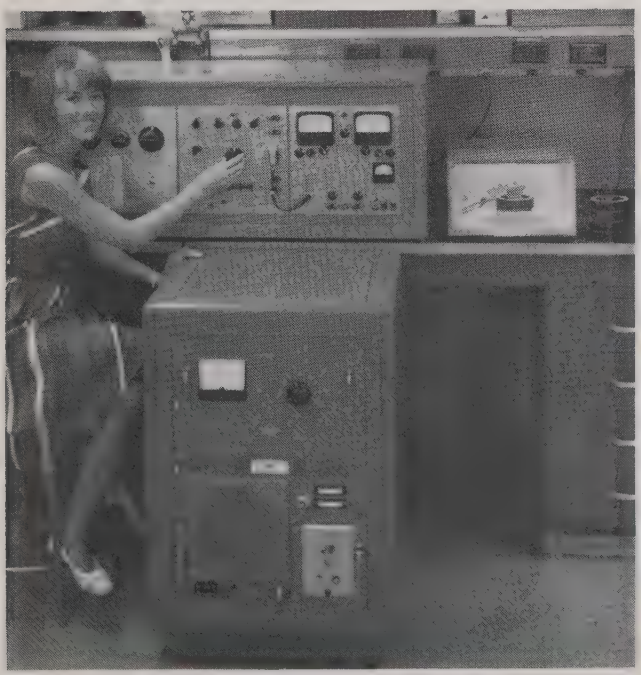
These calibration systems provide accurate and rapid measurement data for production testing applications where plotted or digital data is desired in the manufacture of transducers. Transmitting or receiving transducers can be measured for such parameters as transmission response, receiving response, complex impedance, beam pattern and complex power. See Figure 1.

AUTOMATIC HIGH SPEED COMPONENT TEST SYSTEMS

Through the use of highly accurate and high speed Dranetz instrumentation, complex measurements can be made in production testing with a minimum of operator interventions. These systems can be used for rapid testing of discrete components as well as complex networks. Typical of a system built and designed by Dranetz is the one shown in Figure 2, used for testing piezoelectric ceramic elements at high field strengths. Consisting of a floor-mounted signal source and Dranetz instrumentation and interface equipment, the system is capable of testing up to 6 KV rms at various frequencies with a maximum vector power of 50 KVA. Direct and accurate readings of capacitance and dissipation factor are provided on panel meters and go/no-go indicators integrated into the system.

DATA ACQUISITION AND LOGGING SYSTEMS

Dranetz designs and manufactures complete data acquisition systems for special or general purpose applications. These systems provide automatic measuring and recording of digital and analog data from transducers or other sources and, through signal conditioning, modulating and multiplexing, prepare the data for entry onto magnetic tape for computer analysis or processing. The systems are comprised of highly accurate, flexible components from the Dranetz family of instrumentation and instruments from other manufacturers.



High voltage dielectric test system for measuring capacitance and dissipation factor at levels up to 6 KV rms.

SELF-TEST AND AUTOMATIC CHECK OUT SYSTEMS

Dranetz has had extensive experience in supplying the military and industry with completely automatic and integrated self-test and automatic checkout equipment for use wih complex electronic systems. The self-test equipment can be supplied as an integral part of a system, or as a separate and mobile system to be used on flight lines or production floors.

OPERATOR TRAINING AND EDUCATIONAL SYSTEMS

Design and development of systems for the purpose of training personnel in the operation of complex equipment is another area in which Dranetz has developed considerable experience. Typical of these systems designed and built by the Dranetz Engineering staff are Sonar Operator Trainers which record on magnetic tape acoustic data from the receiving array of sonars while operating at sea under actual conditions. The recordings are played back through Dranetz built simulation equipment at a shore based training facility where sonar students are subjected to the real sounds he will encounter at sea. Such systems are economical solutions to the problems of training skilled personnel.

OTHER DRANETZ ENGINEERED PRODUCTS

- Precision high voltage variable capacitors for use to 10 KV peak
- Miniature Wien Bridge oscillators for use to 500 Khz
- Protective enclosures for testing components to 10 KV peak
- Instrument voltage and current transformers with minimum phase errors and for use to 10 KV rms
- Piezoelectric element sensitivity testers

DRANETZ

ENGINEERING
LABORATORIES
INCORPORATED

1233 NORTH AVENUE, PLAINFIELD, N. J. 07062 • TEL. (201) 755-7080

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A. Main Plant & Offices
Dranetz Eng. Labs., Inc.
1233 North Avenue
Plainfield, N.J. 07062
(201) 755-7080

B. RDP Instruments, Inc.
11565-B Paramount Blvd.
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C. Data-Rep Associates, Inc.
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Chicago, Ill. 60635
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P.O. Box 14
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(315) 446-0220

T. Paratech
2208 N.W. Market St.
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(206) 783-3900

INSTRUMENT PRICE LIST

JUNE 1, 1970

Model:	Price
100B Main Frame Only	$3450.00
100B w/100-PA-1001A	3900.00
100B Mod. 4 Main Frame Only	3697.00
100B Mod. 4 w/100-PA-1001A	4147.00
100C Main Frame Only	4250.00
100C w/100-PA-1001A	4700.00
100-PA-1001A	450.00
100-PA-1004	450.00
100-PA-1008	750.00
100-PA-1009	1100.00
100-PA-1010A	4300.00
100-PA-1011B w/100-PA-1011B-YBB	4300.00
100-PA-1011B-C1	575.00
100-PA-1012A	425.00
100-PA-1013	425.00
202 (excluding 202-PAR-2501 and Assbly #100713)	7400.00
202 (w/202-PAR-2501 & 100713)	7840.00
202A (excluding 202-PAR-2501 and Assbly #100713)	8900.00
202A (w/202-PAR-2501 & 100713)	9340.00
202-PA-2505	3800.00
202-PA-2506	3500.00
206	2100.00
206A	2550.00
215	1890.00
220	4200.00
301, 301R	795.00
301A, 301AR	970.00

Model:	Price
301A-4, 301AR-4	1250.00
302	1330.00
305	1200.00
305A	1580.00
305B	1880.00
305-PA-3001	690.00
305-PA-3002	285.00
320, 320R	795.00
320A, 320AR	915.00
320A(R)/301A(R) Combination	1640.00
501A	2170.00
505	2400.00
506	980.00
506A	1400.00
D10	139.00
D12	800.00
M20	650.00
MR10	85.00
N113A	3000.00
N114	3200.00
SPL-5-BL, SPL-5-OR — Lots of 100	12.00/C
SPL-5-BL, SPL-5-OR — Lots of 1000	8.00/C
SPL-5-BL, SPL-5-OR — Lots of 5000	6.50/C
TR2001	585.00
TR2002	65.00
TR2003	300.00
TR2004	235.00
TR2005	235.00

All prices are F.O.B. Plainfield, New Jersey; Terms 1% 10 days, net 30 days; Prices are subject to change without notice.

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